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LEADERSHIP IN ORTHOPAEDIC SURGERY*

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Members of the American Orthopaedic Association, Guests, Ladies and Gentlemen: My first thought in delivering this address is to assure you how honored I am and how deeply I have appreciated the privilege of serving you as President for the past year; for such an honor is, I presume, part of the harvest of my sowing in the years that too swiftly have gone by. This distinction makes me believe that by good luck my sowing was on fertile soil. My earnest hope is that the friendships which it has been my privilege to enjoy with the members of this Association and their families will continue to flourish. Perhaps there will be more leisure in the coming years to enjoy these friendships.

The fact that the specialty of orthopaedic surgery occupies the high position it holds in the minds of members of the medical profession and the laity puts certain responsibilities on us, not only as individuals but as members of this Association. The American Orthopaedic Association was the first orthopaedic society to be formed in the United States and always has been in the vanguard of the medical specialties of this country in their march of progress toward increased service to the public. This society must continue its leadership.

The Victorian philosopher, Herbert Spencer, stated that in the final analysis specialization was merely another word for progress. New facts are constantly being brought forward; no art or science should be stationary. So we, as specialists, must ever be on the alert to acquire knowledge pertaining to our specialty, and to assimilate, digest, and make use of new facts, thus acquiring that elusive something called wisdom. One hears laments that specialization in medicine has advanced too far, and that it is overdone. It is possible to carry specialization so far that it loses much of its effectiveness. Medicine and the allied fundamental sciences are now so wide in scope, however, that it is utterly impossible for a single individual to comprehend and understand them all. In sur-

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gery, acquiring of the technique properly to execute the complicated operative procedures in the various fields might be possible if the surgeon were merely an operator and technician, but not if he is to be a surgeon in the best interpretation of that term. He must confine himself to certain restricted fields in order to be a master. In medicine we cannot go backward to the old days and deny our patients the benefits of advances made. Specialism is here to stay and will increase in degree, to be limited only by the amount of knowledge that accumulates and by economic factors.

We can laugh and enjoy the criticisms and jibes leveled at specialists and still benefit by them. The poorly trained specialist who blossoms out after a few months' preparation, and is too often of the predatory type, is a disgrace to the profession and should be eliminated; on the other hand, the results accruing to the public through the services rendered by the well trained, honorable, conscientious specialist are practically all on the credit side of the ledger. It is essential, however, that each specialty in medicine realize its responsibilities and take steps to put its house in order. It must disseminate the knowledge that is accruing in its field, see to it that facilities are provided for the proper training of young men, that they may make use of the knowledge so often gathered at great cost, see that its specialists are more or less regulated in their practice, and acquaint the profession and thus the public through some proper channels with what the specialty has to offer and with the names of persons qualified to carry on the actual practice. This is a large order and, as the science and art of orthopaedic surgery have increased in range and scope, the activities of any one rather small group have been found insufficient to cope with this problem. Leadership has been accorded the American Orthopaedic Association, and the Association has not failed. Although it could not, as a society, do all these things, its members in various groups have organized other societies to aid in keeping the specialty on a sound footing.

The most constant thing in the world is change, and altered conditions in our social life must be met. The present era in medicine, as in other walks of life, is characterized by rather profound socialistic tendencies. We cannot quarrel with those changes which are beneficial, and we must not be so short-sighted and selfish as to combat those which bring benefits and solace to the masses of the people, even though they may interfere to some extent with our own habits and ways of conducting our practice.

Some twenty-odd years ago, when it became apparent that orthopaedic surgery was destined to become a lusty member of the family of medical specialties, the Orthopaedic Section of the American Medical Association was formed. Also, in the East, Mid-West, and West, orthopaedic clubs and societies were formed to facilitate the gathering together of those who were interested, and the presenting of orthopaedic problems for discussion. In the Mid-West was formed the Central States Orthopaedic Club which soon outgrew its club clothes and was forced to organize into the Clinical Orthopaedic Society. The Pacific Coast gave birth

to similar organizations, now neatly worked into a collaborating organization that functions admirably to advance orthopaedic surgery in that section. The last year has seen the launching of the American Academy of Orthopaedic Surgeons that promises to link these various district groups into one component society, the better to enable us to advance the things worth while. The various district societies and clubs, however, maintain their individuality, and the larger organization enhances their local influence and usefulness. This year has witnessed the organization and incorporation of the American Board of Orthopaedic Surgery, the chief object of which is to issue certificates to those considered qualified to practise orthopaedic surgery, in order that the profession at large, and through them, the public, may know which of those men who set themselves up as orthopaedic surgeons are qualified by education, training, ability, practice, and character to carry on in that rôle. We are taking our place alongside the other specialties in this commendable undertaking. The American Medical Association approves this, and under the wing of that great organization much good will be accomplished by this movement.

The American Orthopaedic Association, not by official action, but through its members, and always with the tacit consent of its Executive Committee, has fostered these various movements. Orthopaedic surgery is the star of hope to those in that great kingdom of crippledom. No one knows as well as we the sorrow, grief, and yearning that grips the heart of the cripple. Our aim is to lessen that suffering by restoring function, straightening and strengthening weak, crooked limbs and backs, and thus indirectly instilling hope and happiness into hearts that knew them not before. The longer one labors in this sphere, the stronger grow one's sympathies for these unfortunate cripples, and the more roundly does one approve and foster efforts of the laity to provide facilities for the carrying out of projects that will offer aid to them. It is comparatively easy to unlock purses for the care of the crippled child, for the dependent, helpless young have an appeal that melts even the hardest hearts; but to secure proper facilities for the care of that vast and ever-growing army of crippled adults, recruited from among those who suffer injuries consequent to industrial activities and modern, speedy transportation, is more difficult. More help is needed for these unfortunates, and our various activities in this field must be fostered and quickened.

The foresight of the founders of this Association in publishing the papers presented at its meetings has had more influence on the sound development of orthopaedic surgery in the English-speaking world than any other one thing that has been done. The Association first published the papers and discussions in the Transactions. Later, it took the responsibility of owning and publishing the *American Journal of Orthopaedic Surgery* which attained a considerable circulation. In 1922 the title was changed to *The Journal of Bone and Joint Surgery*. Under the guidance of our Editor, Dr. E. G. Brackett, the publication has become increasingly useful and popular. It is the only magazine of its kind published in the

English language; it is owned by the American Orthopaedic Association, the finances being supervised by our Treasurer, Dr. John L. Porter. It is due to the efforts of these two men that *The Journal* is so successful. The British Orthopaedic Association has adopted it as the official organ of the Association, and this has been a great help.

The American Orthopaedic Association, as the parent, so to speak, of the various organizations that have to do with the problems of orthopaedic surgery, must look to the future; but it may, I believe, do much to advance our cause by looking into the past. The character of its membership makes this possible. Membership in this Association is accorded men who have advanced and become leaders in the field. They not only have at their command wisdom, gained by years of exacting labor and effort, but they possess a vast amount of material comprising records of many cases. It is astonishing how lacking we are in knowledge of end results! Who are more fitted than the men in this organization to sum up the results of treatment and properly to evaluate it? We must, therefore, as we are doing at this meeting, discuss methods of treatment and be prepared to pass judgment on their value. Younger men in the other societies will bring up for discussion methods of treatment which may seem old to us, but which present themselves as fresh problems to them. These men will discuss the adaptability of certain procedures, and the technique of their execution; but it will be for members of this society to discuss these problems in the light of greater experience.

We must support the other societies, for they afford us an opportunity of meeting and exchanging ideas and experiences with the younger men, the group from which our membership will be recruited and from which will come those who will take up our work as we drop it.

In conclusion let me reiterate that specialization is essential for progress. Specialization will increase, controlled by two forces,—namely, the fund of new information that is acquired, and economic factors. The price paid by the public for specialization in medicine is not too great; the great benefits outweigh the debits. We must watch to see that those who are taken in as members of this society are well educated, that they are well trained, and that they are men of character, of intellectual honesty, and of integrity. They are future leaders in orthopaedic surgery.

A NEW RADICAL OPERATION FOR POTT'S DISEASE

Report of Ten Cases*

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The principles underlying the treatment of tuberculous spondylitis, which have been universally adopted today, consist of giving rest to and alleviating weight thrown upon the diseased vertebrae by application of an immobilizing bandage, and of promoting the natural processes of healing by general hygienic measures. The operative measures of Calot, Henle, Hibbs, and Albee are essentially immobilizing procedures and are directed to the same purpose,—namely, rest and relief of weight upon diseased vertebrae. Consequently, the purpose of the surgical treatments so far devised does not differ fundamentally from the object of the non-surgical conservative measures.

Through the recent advancement of surgery, it has become possible to remove lesions lying not only within the abdomen, but in practically all the body cavities, including the chest, spine, and cranium. An outstanding example of one of the few exceptions has been the fact that no radical measure for Pott's disease has yet been devised. The reasons for this fact, we believe, may be summarized as follows:

1. The symptoms of the disease are relatively mild, and the patients frequently prefer non-operative treatment.
2. An early diagnosis is often difficult and indication for an operation not easily recognized.
3. A fairly satisfactory result usually follows conservative measures.
4. Since the vertebrae are deeply situated, surgical approach and technical procedures upon them are fairly difficult.
5. Because of the important rôle they play in bearing the body weight, a radical operation upon them must necessarily be followed by instituting a proper substitute for weight-bearing.
6. Tuberculous lesions are especially susceptible to a secondary infection.
7. Even if a secondary infection does not occur, it is often difficult to obtain a primary healing of any surgical wound upon a tuberculous lesion.

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8. The patients who desire a radical operation more often than not present quite severe cases and the postoperative prognosis of such cases, naturally, is frequently unsatisfactory.
9. Even if an early case presents itself for an operation, it is difficult to locate a small localized lesion at operation.
10. Dangers incident to the operation itself are not to be regarded lightly.

The literature on radical operation for Pott's disease shows a series of unsuccessful attempts made by various writers. Tillmanns, Hoeftman, Sick, and Krause each attempted to remove a lesion by laminectomy. An effort was made by each of these surgeons to reach the body of the vertebra by retracting the spinal cord to one side, and to resect the diseased part of the body. However, it was found necessary to section many nerve roots in order to retract the cord sufficiently for the purpose, and, on account of the narrowness of the field of operation, it was impossible to remove the diseased part completely. The practice of leaving the wound open with tampon of iodoform gauze further helped to render the prognosis gloomy, and the mortality was considerable.

Another series of attempts at radical operation was made by Vincent, Parona, Willard, Tillmanns, Schöffer, Treves, and Ménard, each of whom performed a costotransversectomy through a paravertebral incision, approaching a lesion in the body of the dorsal vertebra. Since the primary object of the operation by these surgeons was evacuation of pus, drainage was instituted; and, as a consequence, the majority of the patients succumbed to a secondary infection; in many of the others permanent fistulae resulted; and a complete cure was rare and accidental.

Müller, in a case of suspected sarcoma of the ventral aspect of the sacral promontory, discovered at operation through a median suprapubic incision a cold abscess resulting from caries of the lumbar vertebra. After thoroughly curetting the diseased bone surface with iodoform powder, he sutured the wound. The result from this was excellent, but subsequent attempts at the same procedure in other cases resulted so disastrously that he was forced to discontinue its further use.

Podres approached an abscess in a child of eleven, with paralysis of the upper extremities and difficulties of deglutition and respiration, by an incision along the external border of the sternocleidomastoid muscle, with an excellent result.

Burkhardt performed a similar operation by an incision along the anterior border of the sternomastoid muscle and Payr reached a lesion in the atlas by an oblique incision from the tip of the mastoid process to the mid-line, but these operations have not been repeated by other surgeons.

These attempts at radical operation had been made prior to 1910, in the period of antiseptic surgery. In the recent European and American literature, we fail to find a reference to any new attempt at radical treatment of Pott's disease. The surgery of tuberculous spondylitis has been confined to the methods of immobilization, of which Albee's technique is

the one most widely practised. Thus, up to the year 1932, a radical operation for Pott's disease was not only regarded as an impossibility but anyone who attempted such an operation was branded as a reckless surgeon.

The so called aseptic surgery of today, however, has practically revolutionized many of the operative procedures of the antiseptic age that existed up to 1910. By the present aseptic method a primary healing of the operative wound is the rule and the costal and pericostal tuberculosis are considered to be most amenable to surgical cure. In this period of surgical enlightenment, the question of why a result similar to that in the treatment of costal tuberculosis cannot be obtained by a radical operation for tuberculosis of the vertebra is not easy to answer.

It is doubtless true that in many cases of Pott's disease, the current conservative measures yield results satisfactory to both the surgeon and the patient, but, since the prolonged period of treatment necessary causes considerable inconvenience and economic loss to the patient, the need of a more rational and speedy cure has been recognized, and efforts toward attaining this goal have constantly been made by us.

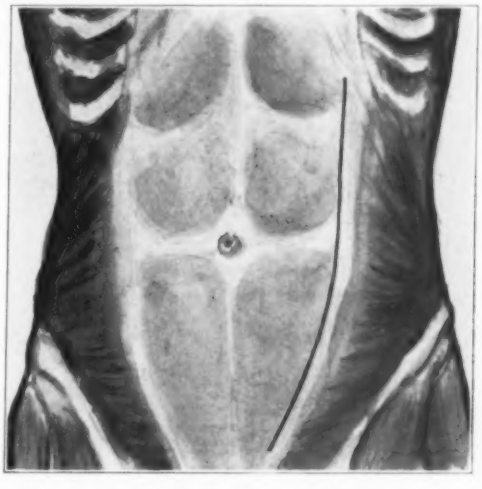

FIG. 1

Pararectal incision usually employed in the present series.

In 1923, we originated a technique of lumbosacral sympathetic ganglionectomy for the purpose of improving the circulatory conditions of the lower extremities, the results of which were reported to the Japanese Surgical Society in 1925. Subsequently, the technique was modified so that now the incision is made on the flank, and the sympathetic chain removed extraperitoneally. During repeated operations by the new technique, it occurred to us that by this approach the vertebral column could be reached with remarkable ease. We felt that a total resection of the body of a vertebra should not be difficult, and a plan for application of this idea to radical treatment of caries of the vertebra has been slowly developed.

THE TECHNIQUE OF OPERATION

A. For Pott's disease of the lumbar vertebrae either general or spinal anaesthesia is employed. A left pararectal incision is usually made in order to avoid injuries to the aorta and the inferior vena cava (Fig. 1). In a case presenting a gravitating abscess on the left side only, the right

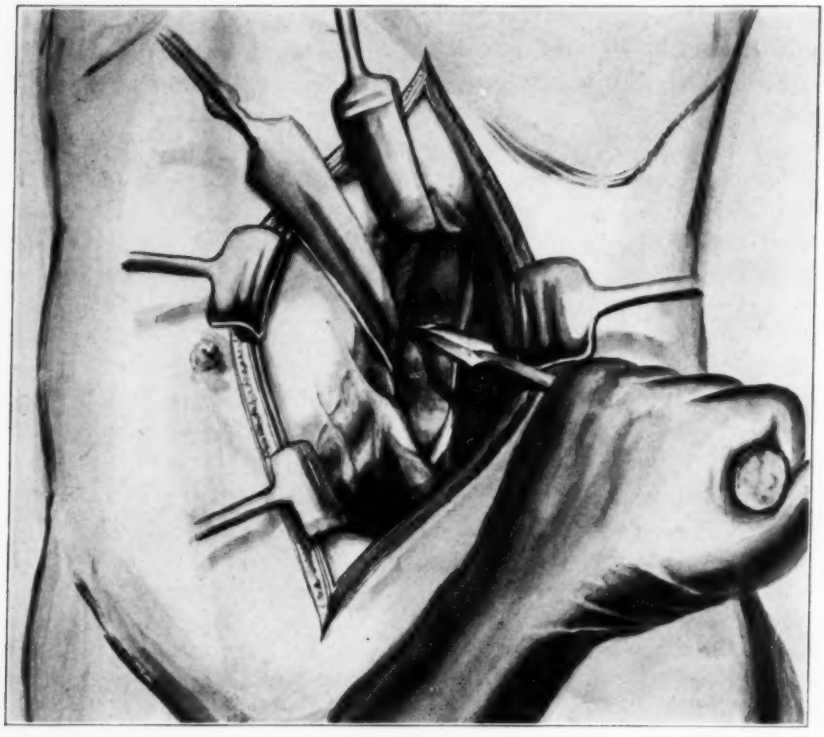

FIG. 2

Extraperitoneal exposure of the body of the lumbar vertebra and resection of the body with a chisel.

pararectal incision is chosen. The peritoneal fold containing the abdominal viscera is retracted toward the mid-line, and by a little further blunt dissection the retroperitoneal space is reached. At this stage of the operation it does not require much more dissection to expose the bodies of the lumbar vertebrae. The anterior longitudinal ligament of the diseased vertebrae is divided in the direction of its fibers, and the granulation tissue and the sequestrum are scraped out with a sharp curet. Then as much of the solid bony tissue forming the wall of the lesion as is deemed necessary is removed by means of a chisel (Fig. 2). The anterior longitudinal ligament is now sutured and the abdomen closed.

If there is an abscess at the site of the proposed operation, it is aspirated previous to the incision. Should more pus be found remaining in the iliopsoas muscle during the operation, the aspiration is repeated under direct vision, and the abscess cavity is opened close to the diseased body of the vertebra. Then the anterior longitudinal ligament of the affected vertebra is incised; the diseased portion of the body is thoroughly curetted out; and the bony tissue forming the wall of the lesion is chiselled off; and, after suturing the divided anterior longitudinal ligament, the cavity of the psoas abscess is closed air-tight close to the curetted body of the verte-

bra, in order to shut off any direct communication between the vertebra and the abscess cavity. The abdomen is now closed. By this technique it is possible to reach the sacrum, and all of the lumbar vertebrae, with the exception of the first lumbar for which a special technique has been devised.

B. For Pott's disease of the first lumbar and the twelfth dorsal vertebrae, a skin incision is made parallel to, and from two to three centimeters away from, the spinous processes of the corresponding vertebrae. The fascia lumbodorsalis is split longitudinally; the sacrospinal muscle is retracted laterally; the transverse process of the first lumbar vertebra, or, in the case of involvement of the twelfth dorsal vertebra, the last rib is resected; and the lesion is reached readily by dissecting deeply. As this technique produced considerable bleeding, however, it was modified as described below.

An oblique skin incision is made, beginning at the level of, and from two to three centimeters away from, the spinous process of the eleventh or twelfth dorsal vertebra, and curving toward the anterior superior spine of the ilium, as in Bergmann's incision for nephrectomy. The oblique and transverse abdominal muscles are incised; the sacrospinal muscle is retracted medially; and the retroperitoneal space is reached extraperitoneally. In this way, resection of the transverse process is made unnecessary and hemorrhage is reduced to the minimum; but the fact that the body of the vertebra is at a considerable distance from the skin incision is an inconvenience. It is difficult to decide which one of these methods is superior, and a new and better approach may possibly be devised in the future. It may be stated definitely, however, that a surgical approach to the bodies of the twelfth dorsal and first lumbar vertebrae is not a very difficult matter.

C. For Pott's disease in the dorsal vertebrae a different incision is necessary. An approach to the bodies of the vertebrae in this region is made by a costotransversectomy in which both the transverse processes of the vertebrae and the corresponding ribs are resected. We have made it our working principle to resect three ribs in order to make an approach to one vertebral body. In this way the field of operation is made ample, and the operative manoeuvers easy of performance. It must be kept in mind, however, that, whereas in those cases in which the ribs are also diseased—as in costal tuberculosis—the pleura is definitely thickened and danger of perforation is slight, in those with healthy ribs there is no hypertrophy of the pleura to insure its safety; therefore, in resecting the normal ribs, care must be exercised against injury to the pleura.

The next consideration is the method of repair of the resected part of the vertebra. We have tried two methods. In a certain number of cases we have tried Albee's technique of immobilization, the transplantation being performed three weeks or more after the radical operation. This technique was found to be safe and perfectly effective in relieving the defective vertebral bodies of their weight-bearing function, but the necessity of dividing the operation into two stages is a definite drawback.

For this reason, we have tried another method in which either a tibial graft or a portion of a rib is implanted into a groove made in the bodies instead of into the spinous processes of the vertebrae. In this procedure the diseased body of the vertebra is first resected; the intervertebral cartilages on both the upper and lower surfaces of the body are either scraped off or trimmed away with a pair of scissors. Then, in the middle of the body of the healthy vertebra below the one resected, a hole about one centimeter deep is bored with a drill perpendicularly to the surface of the disc; and on the side of the body of the healthy vertebra lying above the resected one, a longitudinal groove of the size that corresponds to that of the proposed transplant is made (Fig. 4). A bone graft with one end tapering into a sharp point is obtained from the tibia; the point is forced into the hole previously prepared in the body of the lower vertebra, and the other end of the graft is firmly secured in place by means of a specially made chisel.

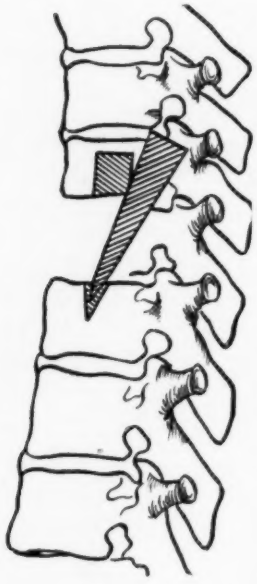

FIG. 3

Schematic drawing to show the direct method of bone transplantation.

Quite naturally one would doubt the efficacy of such a slender graft in compensating for loss of the vertebral body in weight-bearing. In order to determine this point, we removed a body of a lumbar vertebra in the rabbit by the transabdominal route, and transplanted a fibular graft into a groove made in the body of the vertebra above and below the resected one. Three months after the operation, it was found that the bony union at the site of the transplant was firm, that there was a surprisingly large quantity of callus formed between the healthy vertebrae and the graft, and that there was no mobility in any direction in the region of the transplantation; this region of the vertebral column was found to be able to withstand a weight of twenty kilograms. From this experimental finding we have felt that a similar result may be expected in man. It is our expectation to stimulate callus formation by thoroughly chiselling off the eburnated bony tissue of the body of the vertebra previous to transplantation.

REPORT OF CASES

CASE 1. T. U., a farmer's wife, twenty-nine years old, was admitted to the Clinic, April 30, 1932.

Chief Complaint: Dull pain in the lumbar region.

Present Illness: About two years before she had first noticed a dull pain on bending the back, which had gradually increased in intensity till it had become difficult to walk.

Examination showed a young woman of medium build with fairly good nutrition. Both apices and the right anterior chest were slightly dull to percussion and breath sounds were weak; posteriorly, in addition to dullness on percussion, there were sonorous râles.

Locally, the dorsal spine was curved to the right, and there was a marked kyphosis at the first lumbar level with rigidity, but there was no tenderness to palpation or percussion.

Diagnosis: Spondylitis of the first and second lumbar vertebrae.

Radical Operation, May 4, 1932: Under general anaesthesia a curved incision sixteen centimeters long was made, beginning about two fingers' breadth to the left of the spinous process of the tenth dorsal vertebra, curving toward the right and ending at one finger's breadth posterior to and above the posterior superior spine of the left ilium. The fascia and the muscles of the back were incised and retracted, and about five centimeters of the twelfth rib next to the costovertebral articulation, as well as the transverse processes of the first, second, and third lumbar vertebrae, were resected (Fig. 4).

FIG. 4

Case 1. Mrs. T. U. Appearance of the operative wounds shortly before discharge.

Approach to the bodies of these vertebrae was at first attempted close to the mid-line; but, owing to profuse hemorrhage, this attempt was abandoned and we reached the left lateral aspect of the twelfth dorsal, first, second, and third lumbar vertebral bodies by a slightly lateral approach. Tuberculous granulation tissue was found mainly between the first and second lumbar vertebrae; and, as this was scraped out, a trace of pus was noted coming both from the lower part of the first and the upper part of the second lumbar vertebrae. Resection of these evidently diseased portions of the bodies was done, and the surrounding atrophic bony tissue was chiselled away. The anterior surface of the body of the twelfth dorsal vertebra was also curetted. The muscles, muscle sheaths, and skin were then sutured in layers, the patient placed in prone position, and a plaster-of-Paris bed prepared. Immediately after the operation the pulse was rapid and weak; a transfusion of 300 cubic centimeters of blood was given and the patient was returned to bed.

Postoperative course was uneventful and the wound healed by primary intention.

Twenty-seven days afterward, immobilization by the Albee operation was performed, and the patient was discharged with a plaster jacket sixty-one days after the radical operation.

At present the general condition of the patient is excellent, and there is neither any pain nor are there signs of abscess in the region operated upon.

CASE 2. C. M., a married woman, thirty-seven years old, was admitted to the Clinic, May 25, 1932.

Chief Complaint: Pain in the lumbar region and difficulty of locomotion.

Present Illness: In January, 1931, lateral curvature of the spine was first noted. Soon after childbirth, on September 3 of the same year, she had been confined to bed with pain in the lumbar spine and inability to walk, although the pain had somewhat abated at the time of admission.

FIG. 5-B

FIG. 5-A

Case 4. Mrs. C. K. Preoperative roentgenograms showing the vertebral lesion.

FIG. 6-A

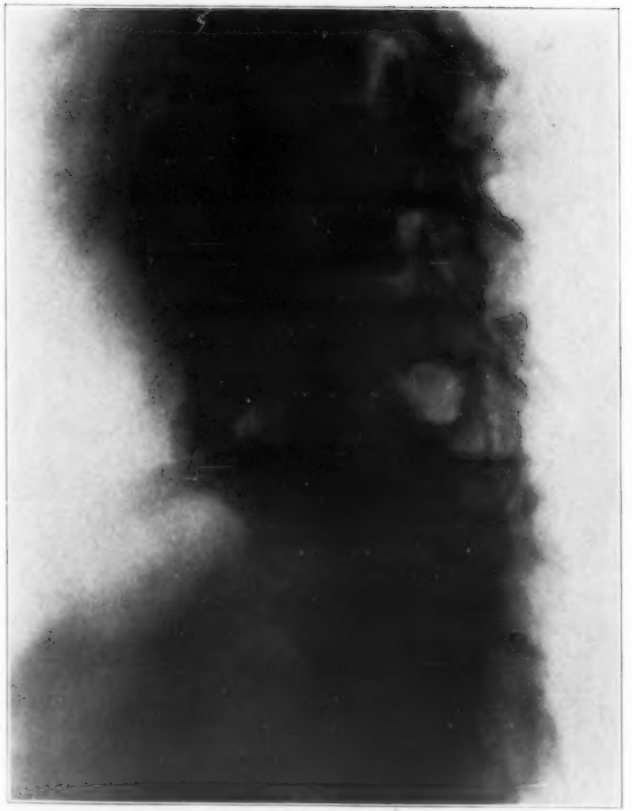

FIG. 6-B

Case 4. Mrs. C. K. Roentgenograms showing the condition of the transplant and the vertebrae sixty days after the one-stage operation.

Examination showed a fairly well nourished woman of middle age. Locally, the lumbar spine was curved to the left, and there was definite rigidity. In the left iliac fossa was palpable an abscess the size of the fist; in the right iliac fossa, also, a slight resistance and fluctuation were noted. The knee and Achilles' tendon jerks were exaggerated bilaterally.

Diagnosis: Spondylitis of the fourth dorsal vertebra with bilateral psoas abscesses.

Radical Operation, May 27, 1932: An incision approximately fifteen centimeters long was made, the center of which passed through a point three fingers' breadth above the left iliac crest, its direction being from above behind anteriorly and inferiorly. The incision was deepened layer by layer until the peritoneum was reached. The peritoneum was then separated from the extraperitoneal tissue by blunt dissection, and the retroperitoneal space was reached. The abscess was aspirated and then opened, and the left anterolateral surface of the body of the fourth lumbar vertebra was exposed. The diseased part was recognized by the roughness of its surface and the brittleness of the tissues. This part was thoroughly curetted out and the bony tissue in the immediate vicinity was cut away with a chisel. The incision that was made in the wall of the abscess was sutured, and the continuity between the abscess cavity and the resected portion of the vertebra was obliterated completely by ligature. The muscles, fascia, and skin were then sutured in layers. Immediately after the operation the patient was placed in a prone position and a plaster-of-Paris bed was made. The patient was returned to bed and ordered to keep the dorsal posture.

Two weeks after the operation, a fistula developed at a part of the operative scar; this gradually closed, however, in the course of two months, when an operation after the method of Albee was performed. A month after this, the patient was discharged with all the wounds nicely healed. The plaster jacket was removed three months after discharge. The original symptoms have cleared up and the patient experiences no difficulty in walking.

In the following cases, only the essential features of each case are given.

CASE 3. K. I., a girl of eighteen years, a dressmaker, was admitted to the Clinic on June 6, 1932. Present illness began in July 1931.

Diagnosis: Spondylitis of the fourth and fifth lumbar vertebrae, with a slight kyphosis of the lumbar spine, a mild degree of lumbar lateral curvature, and an abscess in the right iliac fossa.

Patient appeared moderately well nourished.

Operation, June 10, 1932: The vertebrae were exposed through a right pararectal incision. The lower portion of the fourth lumbar vertebra was found to be sequestrated. With curettage of the necrotic tissue, the upper portion of the fifth lumbar vertebra was also found to be sequestrated and the intervertebral ligament replaced by granulation tissue. After curettage and chiselling off of the eburnated tissue, a defect, three centimeters wide and eight inches long, was exposed. The abscess wall was sutured air-tight and the wound closed in layers.

Second Operation: Three months afterward, immobilization by tibial graft, after the method of Albee, was performed. The patient was discharged 129 days after the first operation.

Result: Six months after discharge, there was no pain nor difficulty of locomotion and no sign of abscess formation. Hypaesthesia of the lower extremities had also disappeared.

CASE 4. C. K., a married woman, forty-eight years of age, was admitted on June 11, 1932. Present illness dated from July 1931.

Diagnosis: Spondylitis of the fourth and fifth lumbar vertebrae, with kyphosis of lumbar spine and bilateral psoas abscesses.

At the age of twenty-seven she had had an operation for caries of the rib. Patient was rather frail and emaciated. Reflexes were hyperactive.

Operation, May 15, 1932: Just before operation, 120 cubic centimeters of pus was evacuated from the right iliac fossa. The peritoneum was reached through a left pararectal incision. A focus of tuberculous pus and a sequestrum were found in the lower portion of the anterior surface of the fourth lumbar vertebra. A part of the body of the fifth lumbar vertebra was also found to be sequestrated and brittle. After curettage of the diseased area and chiselling off of the eburnated tissue, a defect of the vertebrae, the size of a pigeon's egg, was exposed. A wedge-shaped tibial graft was prepared and inserted in the healthy central portion of the fifth lumbar vertebra and in a longitudinal groove made on the fourth lumbar vertebra. The anterior longitudinal ligament was sutured and the wound was closed in layers. The patient was placed in a plaster-of-Paris bed.

The wound healed by first intention and the postoperative course was uneventful. There was no reaccumulation of pus. The patient was discharged on the sixty-third day after operation. The nutrition of the patient was excellent, the reflexes normal, and the gait normal.

Result: In February 1933, the general condition of the patient was satisfactory,—no pain, no abscess reformation, reflexes normal.

CASE 5. Y. I., a watchmaker, twenty-nine years of age, was admitted on June 4, 1932. Symptoms of present complaint began seven years previously. A year later, kyphosis in the mid-dorsal spine developed, for which support was given. There had been a gradual increase of the kyphosis.

Diagnosis: Spondylitis of the tenth dorsal vertebra, with kyphosis.

The patient was of medium build and fairly well nourished.

Operation, June 17, 1932: Approach was made by a left paravertebral incision, twenty centimeters in length, with mid-point at the tenth dorsal vertebra. Segments, three centimeters in length, of the ninth, tenth, and eleventh ribs were resected close to the costovertebral articulations. The transverse processes were also resected. The pleura was separated by blunt dissection. The body of the tenth dorsal vertebra was found to be flattened and there were traces of granulation tissue and a small sequestrum. These were curetted out and the atrophic bone chiselled off. A piece of one of the resected ribs was inserted into the defect of the vertebra. The anterior longitudinal ligament and overlying parts were sutured in layers. The patient was placed in a plaster-of-Paris bed.

The convalescence was uneventful; the wound healed by primary intention, and the patient was discharged forty-five days after the operation. The general condition of the patient was excellent,—no tenderness, pain, nor sign of abscess reformation. Gait was normal and not followed by fatigue or pain.

Result: Eighty-eight days after the operation, the patient's condition was excellent and there was no complaint.

CASE 6. T. F., a farmer, twenty-three years of age, was admitted on August 29, 1932. Present illness dated from November 1931. At the age of eighteen, he had had tuberculous arthritis of the right elbow and, at twenty-one, a dry pleurisy.

Diagnosis: Spondylitis of the second lumbar vertebra, with slight kyphosis.

The patient was of medium build with slightly impaired nutrition.

Operation, August 31, 1932: Under local anaesthesia, approach was made by a paravertebral incision, fifteen centimeters in length, with mid-point at the second lumbar vertebra. The dissection was kept close to the body of the vertebra to avoid the spinal nerves and vessels that emerge from the intervertebral ligament at that area. Necrosis of the right lower portion of the body of the vertebra was discovered. There was no pus. The diseased area was thoroughly curetted and the eburnated tissue in the vicinity was chiselled off, leaving a defect the size of a pigeon's egg. A tibial graft, five centimeters in length and one centimeter in width, was inserted into the bodies of the vertebrae above and below. The anterior longitudinal ligament and overlying tissues were sutured in layers. The patient was placed in a plaster-of-Paris bed.

The convalescence was uneventful and the wound healed by first intention.

FIG. 7-B

FIG. 7-A

Case 8. Miss Y. Y. Preoperative roentgenograms showing the vertebral lesion and downward tilting of the affected body.

FIG. 8-B

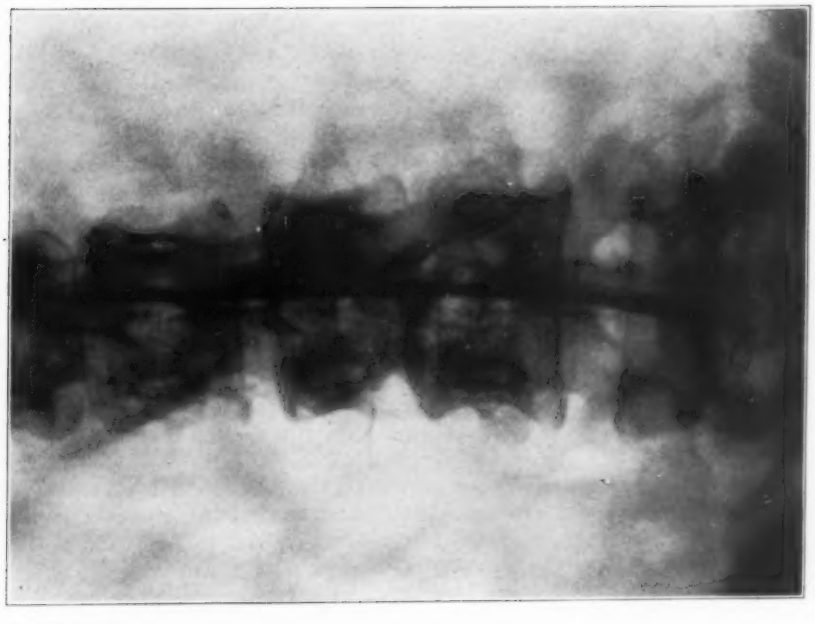

FIG. 8-A

Case 8. Miss Y. Y. Roentgenograms showing the condition of the transplant and vertebrae one month after operation by the Albee method. The lateral view shows how the preoperative downward tilting of the diseased body of the vertebra has been corrected.

Result: The patient was discharged two and a half months after the operation, completely relieved of symptoms.

CASE 7. T. T., a seamstress, aged thirty-four years, was admitted on November 14, 1932. Symptoms of present illness dated back two years. Pain and weakness of the leg were prominent symptoms and at one time the patient had been unable to walk at all.

Diagnosis: Spondylitis of the fourth and fifth lumbar vertebrae, with kyphosis; lateral curvature to the left in the mid-dorsal region; an abscess, the size of a fist, easily palpable in the right iliac fossa; and a smaller mass in the left iliac fossa; signs of pulmonary involvement.

Operation, November 16, 1932: Before operation, 500 cubic centimeters of pus was evacuated by aspiration from the abscesses in the iliac fossae. Approach was made by a left pararectal incision from the level of the umbilicus to the symphysis pubis. The abscess was incised close to the body of the fourth and fifth lumbar vertebrae, the diseased portions of which were curetted, and two fair-sized sequestra were removed. After the intervertebral ligament of the fourth lumbar vertebra was dissected off, pulsation of the aorta was found directly in front of its body. The abscess on the left side was found to communicate with that of the opposite side at this point. The upper portion of this abscess was closed by a purse-string suture, cutting off continuity between it and the resected portion of the vertebrae. The anterior longitudinal ligament and other structures were sutured in layers.

Six days after the operation, stitch abscesses developed, with thick, creamy pus, but the deeper layers were not involved. One month after the operation, there developed pain, redness, and swelling in the right lower abdominal quadrant. Two weeks later, a sinus formed with purulent discharge, which gradually lessened and at the time of this report suggested spontaneous closure in the near future.

Result: At the last report, the general condition of the patient was good,—the lumbar pain and hypaesthesia had disappeared.

CASE 8. Y. Y., a girl, nineteen years of age, was admitted on December 12, 1932.

Diagnosis: Spondylitis of the third lumbar vertebra, with kyphosis and right psoas abscess.

The patient was fairly well nourished, with a suggestion of involvement of the right lower chest. Both knee jerks were exaggerated.

Operation, December 14, 1932: Previous to the operation, the abscess in the right iliac fossa was aspirated. Approach was through a left pararectal incision. With the incision of the anterior longitudinal ligament and the separation of the periosteum, considerable granulation tissue was discovered, which was curetted. Three fragments of sequestra were removed and the bony wall of the lesion was chiselled off. The defect in the bone was filled with a portion of the psoas muscle with pedicle, over which the periosteum of the vertebra and the ligament was sutured. The abdominal wall was closed and sutured in layers and the patient was placed in a plaster-of-Paris bed.

Convalescence was uneventful and the wound healed by first intention.

Second Operation: Twenty-nine days after operation, immobilization by tibial graft, after the method of Albee, was performed. One month later, the patient was discharged.

Result: There was no difficulty in walking and no abscess reformation.

CASE 9. N. Y., railway worker, aged twenty-nine years, was admitted to the Clinic on January 19, 1933. Illness began a year and a half before admission.

Diagnosis: Spondylitis of the second and third lumbar vertebrae, with kyphosis.

Patient was of medium build, with somewhat impaired nutrition. There were suspicious signs in the chest over the right lower posterior lobe. At the age of seventeen, the patient had had pleurisy. Reflexes were exaggerated bilaterally.

Operation, January 20, 1933: Approach was through a left pararectal incision, eight inches in length, at a point two centimeters below the costal arch. In dissecting off the peritoneal fold, a portion was torn, which was immediately sutured. At the origin of the psoas muscle was found a dark-red oblong swelling on the left aspect of the body of the

fourth lumbar vertebra. This was punctured and five cubic centimeters of thick, brownish-gray pus was obtained. The abscess wall was then incised and through the incision the bodies of the second and third lumbar vertebrae were curetted, and several small sequestra were removed. After thorough curettage and chiselling off of the adjacent bony wall, the abscess wall was closed air-tight with purse-string sutures, obliterating its continuity with the vertebral focus. The wound was closed in layers and the patient was placed in a plaster-of-Paris bed.

The wound healed by first intention.

Second Operation: One month later, immobilization by tibial graft, after the method of Albee, was performed.

Convalescence was uneventful and, at the time of making this report, the patient was ready to be discharged.

CASE 10. Y. K., a farmer's wife, aged thirty years, was admitted to the Clinic on January 23, 1933. Present illness began after childbirth, three years previously, with complaint of pain, accompanied by spastic paralysis of the lower legs and feet, with hypaesthesia of both thighs. This improved after seven months.

Diagnosis: Spondylitis of the twelfth dorsal and first lumbar vertebrae, with kyphosis.

Patient was of moderate build with somewhat impaired nutrition.

Operation, January 25, 1933: Approach was through an oblique incision, seventeen centimeters in length, from the level of the tenth dorsal vertebra and three fingers' breadths to the left, extending downward and anteriorly. Segments of the eleventh and twelfth ribs, three centimeters and five centimeters long respectively, together with a part of the corresponding transverse processes, were resected. During this portion of the operation, a thick, creamy pus escaped from the region of the eleventh dorsal vertebra. Dissection along the body exposed the anterior surface where were found several sequestra, varying in size from 2.5 centimeters to 3.5 centimeters. The granulation tissue was curetted out and the surrounding bony tissue chiselled away. The anterior longitudinal ligament and overlying structures were sutured in layers, and the patient was placed in a plaster-of-Paris bed.

The general postoperative conditions were satisfactory, with total disappearance of pain. The wound healed by first intention. Immobilization by the Albee operation is to be performed.

DISCUSSION

Of the ten cases in which this technique of radical operation on the vertebrae has been used, all except two cases showed a healing by first intention. In one of the two cases, in which fistula had developed, its spontaneous closure occurred quite early and the patient was discharged in satisfactory condition a month after operation by the Albee method (Case 2). In the other case, discharge from the sinus has greatly diminished and there is evidence to indicate its spontaneous healing in the near future. In all the cases the complaints, for the relief of which the patients sought our aid, have disappeared following the radical operation. This result is especially significant when we consider the fact that all these cases were fairly well advanced, with destructive lesions of the bodies of the vertebrae demonstrable not only roentgenologically, but also at operation.

In dealing radically with these cases, it has been our practice first to make thorough, roentgenographic studies in order to obtain full information regarding the site and extent of the lesion, without which a proper approach could not be planned. In carrying out our technique on lumbar lesions, separation of the peritoneum has frequently been difficult on ac-

count of adhesions, but it has always been possible to accomplish it without any danger of infection.

In the radical treatment of the lesion we have felt that it is not sufficient merely to curet out the sequestrum and granulation, but that the eburnated bony wall of the lesion must also be thoroughly chiselled off, in order that subsequent regeneration of bone may be stimulated.

The fact that a cold abscess in Pott's disease heals by aspiration alone, during a course of successful conservative treatment, has been frequently observed. For this reason we have merely aspirated the contents of the abscess and obliterated any direct communication between the abscess and the vertebral lesion by suture of the abscess wall, and avoided a danger of secondary infection which might occur should we curet the abscess cavity or resect its wall. The results of this procedure (Cases 2, 3, 4, 7, and 8) were satisfactory, no reformation of the abscess having occurred in any case, except one.

In the repair of the defect in the body of the vertebra produced by its resection, we have either performed Albee's immobilization operation (Cases 1, 2, 3, 8, and 10) or inserted a bone transplant directly into the defect (Cases 4, 5, and 6); and in none of the cases so treated have we found an occurrence of, or increase of, already existing kyphosis. This outcome confirms our experimental results which showed that a slender piece of bone transplanted into the place of a vertebra is able to assume the weight-bearing function surprisingly well. Postoperative roentgenograms have further shown that, by chiselling off the eburnated bone forming the wall of a lesion, subsequent regeneration of bone is definitely enhanced. The transplant itself proliferates and becomes enlarged. These findings constitute a further clinical confirmation of the results of our experiments elsewhere reported. Even if recurrence of Pott's disease should follow our operation, we are certain that we have not done any real harm, since all that has actually been done, except the resection, is a surgical immobilization.

It appears to be quite logical to suppose that an operation at an early stage of the disease is desirable. It is certain, however, to be extremely difficult at an early stage to locate the lesion on the operating table; and, consequently, an early operation seems to us, at present, to be impossible. With the exception of cases with fistula, in which there is a danger of secondary infection, of cases with serious parenchymatous lesions, and of those in which the bodies of the vertebrae are extensively destroyed or more than two different parts of the spine are involved, the operation that we have presented here is applicable. That, with the above exceptions, the new radical method may be applied at any stage of the disease is shown by the satisfactory results obtained in our series, all of which were fairly advanced cases.

CONCLUSIONS

1. Disinfection of the field of operation must be most thorough.
2. For Pott's disease involving the lumbar vertebrae below and in-

cluding the second, our pararectal incision with extraperitoneal approach is advantageous, in that the resection of the body is comparatively easy and danger of contamination of the peritoneum is obviated.

3. For resection of the body of the twelfth dorsal or first lumbar vertebra, an oblique incision, similar to that of Bergmann's for nephrectomy, is accompanied by least hemorrhage.

4. A preliminary costotransversectomy enabled us to resect the body of a dorsal vertebra.

5. In performing a radical operation, it is not only necessary to be thorough in curettage, but the eburnated bony tissue of the immediate vicinity must also be chiselled off, as this manoeuver definitely favors the subsequent regeneration of bone.

6. A complicating cold abscess heals by mere aspiration of its contents and obliteration of its communication with the original focus.

7. In a series of experiments on the rabbits we have proved that when autotransplantation of bone is made into the place of a resected body of vertebra, a new bone is formed on the line of contact between the healthy vertebra and the transplant; the transplant itself grows by proliferation of its own tissue; and a weight of twenty kilograms is easily withstood by the transplanted segment of the spine.

8. A defect in the body of the vertebra caused by resection may be repaired either by an operation after the method of Albee or by a direct transplantation of a piece of the patient's own tibia or rib, without subsequent disturbance of weight-bearing function, as shown by the fact that a kyphosis does not develop, nor does any increase of a preexisting kyphosis occur.

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THE TREATMENT OF LEGG-CALVÉ-PERTHES DISEASE WITHOUT WEIGHT-BEARING *

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The question of the treatment of Legg-Calvé-Perthes disease is one of interest to all surgeons treating diseases of the hip joint. The author became interested in the treatment of this condition through the study of young patients in whom the diagnosis of tuberculosis of the hip was made during the period from 1909 to 1913. The patients were treated by means of traction in bed, traction in hip splints, or with plaster-of-Paris spicas. No weight-bearing was allowed. In a number of cases the final result was an apparently healed hip joint with motion through a nearly normal range. No roentgenograms of those patients are now available and no lantern slides. A restudy of the patients who had recovered with movable hips led to the belief that these particular patients had been suffering from the changes in the epiphysis of the femur, now classified as Legg-Calvé-Perthes disease. The results shown induced the author to use the same methods of treatment in subsequent cases in which the diagnosis of an epiphysitis seemed definite and was made at a time when roentgenographic studies were more satisfactory. Fortunately, lantern slides were made from the roentgenograms of some of these later patients; so that, while the original roentgenograms have been destroyed, a limited number of slides are available. The author has satisfactory lantern slides of two such cases and also has films showing the present condition of these patients, after a period of over ten years since they were discharged as cured. The slides of another fairly early case are also available, in which the same method was attempted, but where, through lack of cooperation on the part of the patient, the method was not carried out. Still more recently three cases have been treated by freedom from weight-bearing, which was maintained by keeping the patient in bed or in a wheel chair.

From a study of these six cases certain facts seem to be demonstrated, although it may be argued that six cases are not sufficient to prove the value of the method.

Studying Cases 1, 2, and 3, which have been under constant observation and supervision at the Wallum Lake Sanatorium of Rhode Island, it is evident that for the most part the clinical picture follows very closely the roentgenographic findings.

In Case 1 the diagnosis was made early and treatment was begun at once. This treatment consisted of rest in bed without weight-bearing, but without traction or other fixation. The roentgenograms later showed increased change in the head and with it increased clinical changes. As

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time went on, the head began to be more regularly calcified, and with this improvement the clinical findings became less abnormal. Finally the clinical examination was essentially negative and the roentgenographic appearance so nearly that of a normal hip that it is necessary to compare it with the other side to prove that it is not normal. This "cure" required four years, but no loss in education had resulted as, in the institution where the boy was, he had had all the advantages of an ordinary school. Further, it would seem that in a hip showing the structure and shape of the epiphysis such as is now present, late osteo-arthritic changes could not occur.

In Case 2, which was bilateral, the diagnosis was made very late in the instance of the right hip, and fairly late in the instance of the other hip. The clinical findings corresponded closely with what might be expected from the roentgenographic appearance, and the subsequent clinical course has followed the changes as shown by x-ray. It is of interest to note that, to a certain extent, the dome shapes of the epiphyses have been restored, although not completely.

Case 3, which was unilateral, was diagnosed earlier than Case 2. Here again the clinical findings followed the successive roentgenograms, and again the dome shape has reformed, though not completely.

Case 4 is one of the two patients who have been followed for a period of over ten years. The diagnosis was made early and non-weight-bearing instituted at once. This patient was kept ambulatory by means of a traction hip splint and crutches, using a high sole on the opposite shoe. Here again the clinical notes show that the course of the process followed the roentgenographic findings. No original films or plates are available, but from some of them lantern slides had been made and from these slides the prints have been produced. This is the reason for the rather poor illustrations that are offered. However, it seems essential to present them as otherwise there would be no positive evidence of the early condition. The last illustration of Case 4 was made from a roentgenogram taken recently, ten years after the patient was discharged. The patient has been doing heavy work, and has no symptoms and almost no demonstrable evidence of his early condition.

Case 5 is also one that has been followed for ten years since the boy was discharged as cured. It shows that a satisfactory result may be obtained even in a patient where, for a considerable time, the condition was so acute that rest in bed was not sufficient to overcome the muscle spasm and pain. It was therefore necessary to use a series of plaster-of-Paris spicas; during this time the patient was kept in bed. When the spasm and tenderness subsided, a traction hip splint was substituted and he became ambulatory. The result, ten years after discharge, is a hip that is almost perfectly normal although, since discharge, no restriction in use has been in force. These two cases, Cases 4 and 5, would tend to show that, in a so called cured hip, showing normal shape and bone structure, late changes, due to maladjustment of the head and acetabulum, do not occur.

CASE 1 (Figs. 1–14). George La R., aged six years.

FIG. 1

Roentgenogram, October 18, 1929. Very slight irregular decalcification of left capital epiphysis.

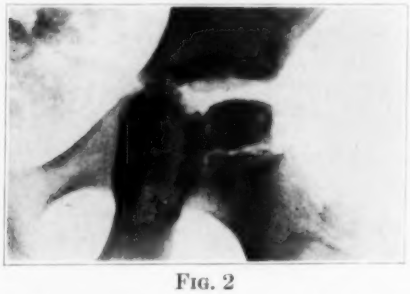

FIG. 2

Roentgenogram, January 18, 1930. Fragmentation of left capital epiphysis.

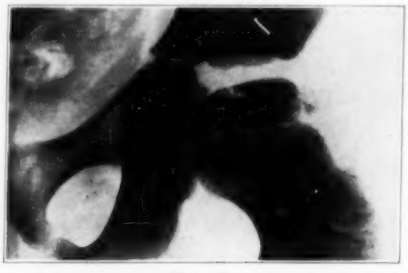

FIG. 3

Roentgenogram, May 12, 1930. More fragmentation and flattening of epiphysis, and broadening of neck.

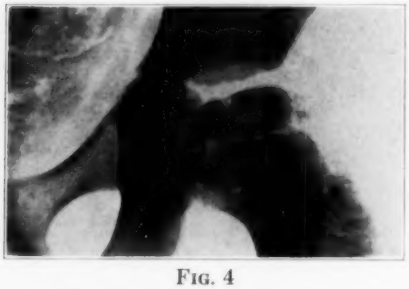

FIG. 4

Roentgenogram, July 9, 1930. Increased fragmentation.

FIG. 5

Roentgenogram, November 20, 1930. Further decalcification of epiphysis.

FIG. 6

Roentgenogram, March 19, 1931. Less flattening of epiphysis.

FIG. 7

Roentgenogram, July 19, 1931. Epiphysis approaching normal curve, and density more uniform.

CASE 1 (*Continued*)

FIG. 8

Roentgenogram, November 10, 1931. Surface of epiphysis smoother.

FIG. 9

Roentgenogram, March 11, 1932. Density and shape of epiphysis nearly normal.

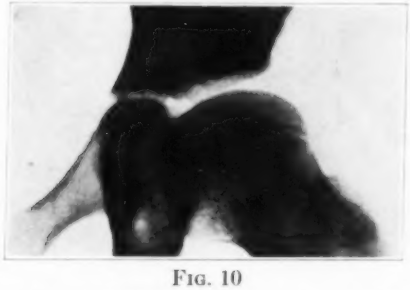

FIG. 10

Roentgenogram, November 1, 1932. Head is still slightly broad, but bone structure appears normal.

FIG. 11

Roentgenogram, December 27, 1932. Hip appears normal, except for slight broadening of epiphysis and of neck.

FIG. 12

Roentgenogram, April 17, 1933. Less broadening of epiphysis and of neck.

FIG. 13

Roentgenogram, June 9, 1933. Hip appears normal except by comparison.

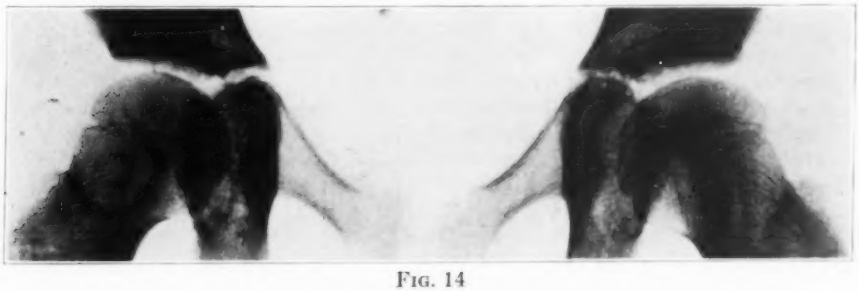

FIG. 14

Roentgenogram, December 30, 1933. Hip normal except by comparison.

Case 6 is taken as a single illustration of what has occurred in a number of patients where weight-bearing has been permitted or where, as in this case, weight was borne although the patient was ordered not to do so. At first not much damage was done, so little, in fact, that he was not put to bed. Later the marked change in the position and shape of the head was evident, and, although there is still not much clinical evidence of difficulty, it seems probable that changes will develop, since other patients with a similar history and similar fundamental changes show, at forty or forty-five years of age, very marked osteo-arthritis, with hips so painful that operative treatment is not only justified but seems absolutely necessary.

Cases 1 to 5 inclusive are given in as much detail as possible to show that, after sufficient restoration of the epiphysis is obtained, partial weight-bearing, and then complete weight-bearing, and finally unrestricted use of the hip may be allowed without danger of deformity resulting. These cases seem to present evidence that justifies the belief that a hip, during the period in which there is such alteration in the epiphysis, is not fit for weight-bearing. The author believes that it is the pressure made by bearing weight that causes the flattening and sliding of the epiphysis and that, even when some flattening and sliding or migration have occurred, a considerable restoration may be obtained by the institution of non-weight-bearing.

The cases illustrated show clearly that the head may resume much of its normal shape, structure, and position if no force is applied to distort it or cause it to migrate. Frequent roentgenograms, as well as very careful clinical observation, are essential to determine the time of beginning weight-bearing. The three cases treated by rest in bed without fixation or traction would seem to indicate that movement is not, as a rule, detrimental and may possibly be of importance in maintaining the nutrition of the surrounding tissues and possibly of the epiphysis as well. It is possible, too, that a consideration of these patients may furnish an argument in favor of earlier fixation of tuberculous hips in children.

Brief case histories are given:

Case 1. George La R., six years of age, when first seen October 2, 1929, had had symptoms in left hip of three months' duration. All motions of the left hip were slightly limited and the left leg was one-eighth of an inch short. The roentgenogram, taken on October 18, 1929, (Fig. 1) showed very slight irregular decalcification of the capital epiphysis. The patient was ordered to remain in bed, absolutely without weight-bearing.

January 18, 1930: The examination was the same, but definite fragmentation of the epiphysis was shown in the roentgenogram (Fig. 2).

May 12, 1930: The examination was the same but the roentgenogram (Fig. 3) showed more fragmentation of the epiphysis and at that time showed some flattening of the epiphysis and some broadening of the neck.

July 9, 1930: The hip showed less limitation of motions but the roentgenogram (Fig. 4) showed increased fragmentation.

November 20, 1930: On examination the hip was the same as before, except that the leg was one-quarter of an inch short and the roentgenogram (Fig. 5) showed further decalcification of the epiphysis.

March 19, 1931: All motions of the hip were still slightly limited, but the roentgenogram (Fig. 6) showed less flattening of the epiphysis.

July 19, 1931: The hip motions were still slightly limited, but the roentgenogram (Fig. 7) showed an epiphysis, the curve of which was approaching normal and its density was more uniform.

November 10, 1931: The motions of the hip were less limited and the leg only one-eighth of an inch short. The roentgenogram (Fig. 8) showed the surface of the epiphysis to be smoother. At that time the patient was allowed to go to school in a wheel chair. Up to that time he had had bedside instruction.

March 11, 1932: Examination of the hip showed slight limitation of external rotation and of hyperextension. All other motions were normal as compared with the opposite side. The roentgenogram (Fig. 9) showed the density and shape of the epiphysis nearly normal.

July 13, 1932: Examination was negative except for very slight limitation of hyperextension. Roentgenograms taken on this date showed the bone structure to be nearly normal, but the head was still slightly broader than normal.

November 1, 1932: The hip still showed slight limitation of hyperextension and the roentgenogram (Fig. 10) showed a head that was slightly broader than normal, but otherwise there was little difference in the two sides. At this time, approximately three years from the time treatment was begun, the boy was allowed partial weight-bearing.

December 27, 1932: All motions of the hip were free and the roentgenogram (Fig. 11) showed a normal head, except for slight broadening of the epiphysis and of the neck. The length of the weight-bearing periods was increased, but the boy still used crutches.

April 17, 1933: Hip motions continued to be free and the roentgenogram (Fig. 12) showed less broadening of the head and neck. At this time he was allowed to give up crutches part of the time (three and a half years from beginning of treatment).

June 9, 1933: The hip motions were all free; the lengths of the legs the same, and the patient walked without limp. The roentgenogram (Fig. 13) was normal except by comparison. From that time no restrictions were enforced (three years and eight months from beginning of treatment).

December 30, 1933: The examination of the hip was entirely negative; the legs were the same length; there was no limp in walking. Patient had had no restrictions for five months. Roentgenogram (Fig. 14) showed a hip that was normal except by comparison with the opposite side.

CASE 2. William G. was seven years old, when first seen July 10, 1929. Patient had had symptoms from the right hip for three years, for which no treatment had been given, and he had not complained of his left hip. Examination showed both legs to be the same length. The right hip showed marked limitation of all motions and the left hip moderate limitation of all motions. The roentgenogram (Fig. 15) showed marked flattening and broadening of the epiphysis and broadening of the neck of the right femur and marked irregularity of density with some flattening of the epiphysis and broadening of the neck of the left femur. The patient was ordered to rest in bed with absolutely no weight-bearing.

November 11, 1929: The hip motions were less limited, and the roentgenogram (Fig. 16) showed increased density of the epiphysis of each femur. Permission was given for the patient to go to school in a wheel chair, but with absolutely no weight-bearing.

March 29, 1930: The motions of both hips were freer and the roentgenogram (Fig. 17) showed more regular density of each epiphysis.

July 8, 1930: The motions of the hips were freer and the roentgenogram (Fig. 18) showed the epiphysis of the right hip to be thicker and the surface of the left capital epiphysis to be smoother.

November 20, 1930: The motions of both hips were freer and the roentgenogram (Fig. 19) showed each capital epiphysis to be slightly more dome-shaped.

CASE 2 (Figs. 15–28). William G., aged seven years. Right hip, symptoms of three years' duration; left hip, no complaint. Examination: Legs same length; markedly limited motions of right hip; moderate of left.

FIG. 15

Roentgenogram, July 10, 1929. Marked flattening and broadening of epiphysis and broadening of neck of right femur. Marked irregularity of density, with some flattening of epiphysis and broadening of neck of left femur.

FIG. 16

Roentgenogram, November 11, 1929. Increased density of epiphysis of each hip. Hip motions less limited.

FIG. 17

Roentgenogram, March 29, 1930. Density of each epiphysis more regular. Motions freer.

CASE 2 (*Continued*)

FIG. 18

Roentgenogram, July 8, 1930. Right epiphysis thicker. Articular surface of left smooth.

FIG. 19

Roentgenogram, November 20, 1930. Each epiphysis more dome-shaped.

FIG. 20

Roentgenogram, March 19, 1931. Articular surface of right hip smoother.

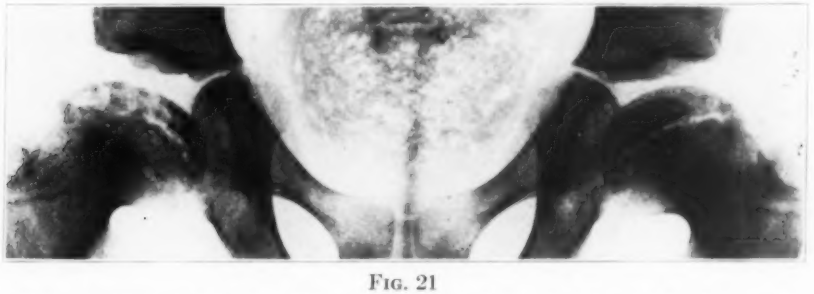

FIG. 21

Roentgenogram, July 9, 1931. Articular surface of right epiphysis smooth. Structure of left epiphysis nearly normal.

CASE 2 (*Continued*)

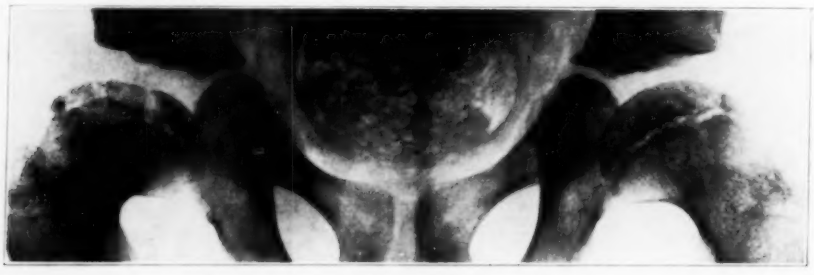

FIG. 22

Roentgenogram, November 10, 1931. Epiphyses unchanged since July 9, 1931.

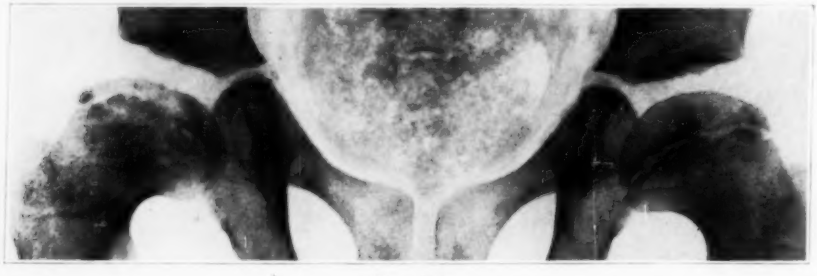

FIG. 23

Roentgenogram, March 9, 1932. No change in epiphyses since July 9, 1931.

FIG. 24

Roentgenogram, July 13, 1932. Epiphysis of right hip more dome-shaped and more dense. Epiphysis of left hip nearer normal in shape and density.

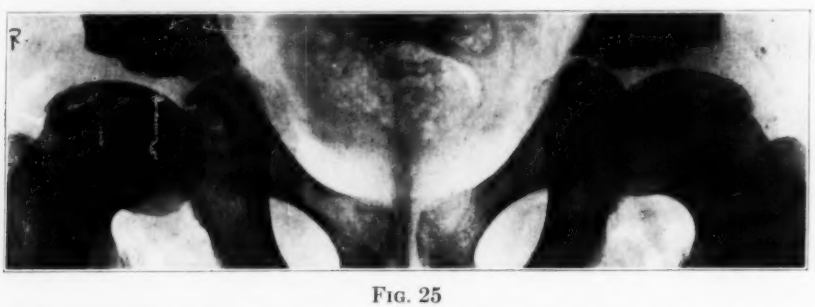

FIG. 25

Roentgenogram, October 29, 1932. Almost identical with that of July 13, 1932.

CASE 2 (*Continued*)

FIG. 26

Roentgenogram, June 6, 1933. Epiphysis of right hip is nearly normal in density, but is still flattened and broadened and neck is broad. Epiphysis of left hip shows nearly normal dome, but is broadened and neck is moderately broadened. All motions free except slight limitation of hyperextension of each hip.

FIG. 27

Roentgenogram, July 27, 1933. Structure of right epiphysis nearly normal and of left almost normal. Hyperextension still slightly limited in each hip. Legs same length.

FIG. 28

Roentgenogram, October 10, 1933. No change appreciable in either epiphysis as compared with roentgenogram of July 27, 1933. Motions of both hips free, except slight limitation of hyperextension of both. Motions are painless. Legs same length.

CASE 3 (Figs. 29–40). Louis A., aged seven years.

FIG. 29

Roentgenogram, May 7, 1930. Irregular calcification of right hip.

FIG. 30

Roentgenogram, September 3, 1930. Right capital epiphysis irregular in shape and in calcification. Adjacent part of neck irregular in calcification.

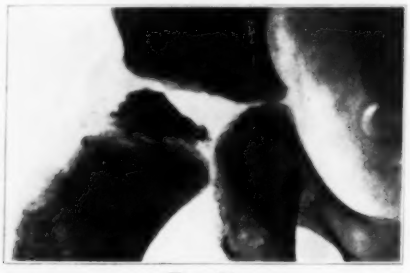

FIG. 31

Roentgenogram, January 7, 1931. Epiphysis very irregular in shape and density.

FIG. 32

Roentgenogram, May 13, 1931. Epiphysis denser, but very irregular and apparently displaced slightly upward and outward.

FIG. 33

Roentgenogram, September 21, 1931. Epiphysis very irregular in shape and density.

FIG. 34

Roentgenogram, January 15, 1932. Epiphysis very irregular in density, but it is more dome-shaped and shows less evidence of slipping.

CASE 3 (*Continued*)

FIG. 35

Roentgenogram, May 6, 1932. Epiphysis more regular in shape and density.

FIG. 36

Roentgenogram, October 28, 1932. Density of epiphysis more regular, but articular surface still slightly rough.

FIG. 37

Roentgenogram, February 23, 1933. Epiphysis nearer normal in density. Position of epiphysis in relation to neck fair.

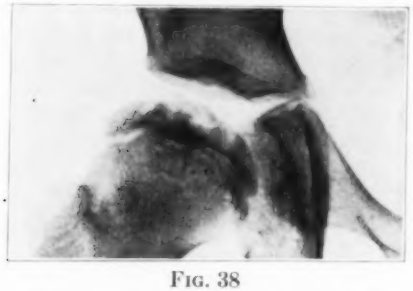

FIG. 38

Roentgenogram, June 6, 1933. Epiphysis irregular in density.

FIG. 39

Roentgenogram, July 25, 1933. Epiphysis still irregular in density, but slightly more dome-shaped and articular surface smoother.

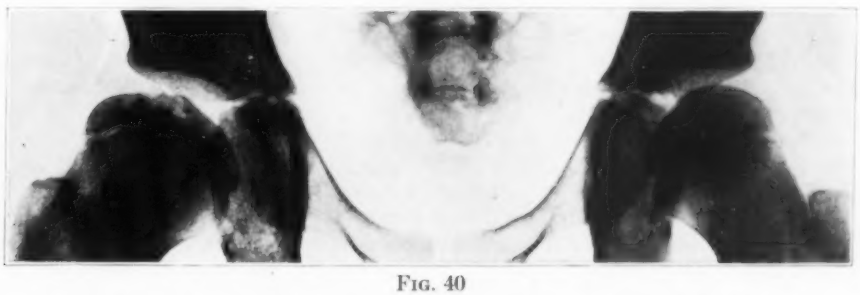

FIG. 40

Roentgenogram, December 11, 1933. Epiphysis nearer normal in density.

March 19, 1931: Examination showed no change in the hip motions. The roentgenogram (Fig. 20) showed the surface of the right hip to be smoother.

July 9, 1931: The examination showed condition still unchanged from that of November 20, 1930, but the roentgenogram (Fig. 21) showed the surface of the right hip to be smooth and the structure of the left epiphysis to be nearly normal, though the shape was not normal.

November 10, 1931: The motions of the right hip were only slightly limited and the motions of the left normal. Legs were the same length. The roentgenogram (Fig. 22) showed no changes in the epiphyses from those seen July 9, 1931.

March 9, 1932: Examination showed all motions of the right hip to be free except for slight limitation of hyperextension and of internal rotation. The motions of the left hip were free. The roentgenogram (Fig. 23) showed no change since July 9, 1931.

July 13, 1932: Motions in both hips were free except for slight limitation of hyperextension in each. Roentgenogram (Fig. 24) showed the epiphysis of the right hip more dome-shaped and more dense and the epiphysis of the left nearer normal in shape and density.

October 29, 1932: No appreciable changes were evident by examination from those seen July 13, 1932, except that the right leg was one-quarter of an inch short. The roentgenographic appearance (Fig. 25) was unchanged from that of July 13, 1932.

June 6, 1933: All motions of both hips were free except for slight limitation of hyperextension in each. Roentgenogram (Fig. 26) showed the right epiphysis nearly normal in density but still flattened and broadened and the neck broadened, while the left showed a nearly normal, dome shape of the epiphysis, though it was still broadened and the neck was broadened.

July 27, 1933: Hyperextension of each hip was still slightly limited; legs were the same length. The roentgenogram (Fig. 27) showed the bone structure of the right epiphysis nearer normal and that of the left epiphysis almost normal. At this time the patient was allowed partial weight-bearing with crutches (four years from the time treatment was begun).

October 10, 1933: Patient had been bearing partial weight for three months. All motions of both hips were free except for slight limitation of hyperextension in each. The hips were painless; and the legs the same length. The roentgenogram (Fig. 28) showed no appreciable changes from those evident on July 27, 1933.

Case 3. Louis A. was seven years old when first seen on May 7, 1930. He had had symptoms in the right hip of three months' duration. Examination showed all motions of the right hip limited and the right leg one-quarter to three-eighths of an inch short. The roentgenogram (Fig. 29) showed irregular calcification of the right capital epiphysis. The boy was ordered to rest in bed, with no weight-bearing but no fixation.

September 3, 1930: All motions of the right hip were limited and the hip was slightly sensitive. The leg was one-quarter of an inch short. The roentgenogram (Fig. 30) showed the capital epiphysis irregular in shape and in calcification, and the adjacent part of the neck was irregular in calcification.

January 7, 1931: All motions of the right hip were considerably limited, and the hip showed five degrees of permanent flexion. The leg was three-eighths of an inch short. Roentgenogram (Fig. 31) showed the epiphysis very irregular in shape and density.

May 13, 1931: All motions of the hip were much limited, and the hip showed ten degrees of permanent flexion. The leg was three-eighths of an inch short. The roentgenogram (Fig. 32) showed the epiphysis to be denser, but very irregular in shape and apparently displaced slightly upward and outward.

September 21, 1931: All motions of the hip were limited and the hip showed fifteen degrees of permanent flexion. The leg was one-half inch short. The roentgenogram (Fig. 33) showed an epiphysis very irregular in shape and density.

January 15, 1932: All motions of the hip were more free, but the hip still showed ten degrees of permanent flexion. The leg was three-eighths of an inch short. The roent-

genogram (Fig. 34) showed an epiphysis very irregular in density, but it was more dome-shaped and showed less evidence of slipping.

May 6, 1932: All motions of the hip were nearly normal except for ten degrees of permanent flexion. The leg was three-eighths of an inch short. The roentgenogram (Fig. 35) showed an epiphysis more regular in shape and density.

October 28, 1932: All motions of the hip were free except for slight limitation of abduction. The leg was three-eighths of an inch short. The roentgenogram (Fig. 36) showed more regular density of the epiphysis, but the surface was still slightly rough.

February 23, 1933: The hip showed slight limitation of hyperextension and of abduction. The leg was three-eighths of an inch short. The roentgenogram (Fig. 37) showed an epiphysis nearer normal in density and its position in relation to the neck nearer normal.

June 6, 1933: All motions of the hip were free, but the leg was still three-eighths of an inch short. The roentgenogram (Fig. 38) showed an epiphysis somewhat irregular in density.

July 25, 1933: All motions of the hip were free, but the leg was still three-eighths of an inch short. The roentgenogram (Fig. 39) showed an epiphysis still irregular in density, but it was more dome-shaped and the surface was smoother.

December 11, 1933: All motions of the hip were free. The leg was still three-eighths of an inch short. The roentgenogram (Fig. 40) showed an epiphysis nearer normal in density and shape with something of a dome. Clinically and by roentgenographic examination the patient is nearly ready for partial weight-bearing after three and one-half years of treatment.

CASE 4. William H. was nine and one-twelfth years old when first seen on August 4, 1921. He had had symptoms from his right hip for about one year. Examination showed all motions of the right hip slightly limited and the right leg one-half inch short. Roentgenogram (Fig. 41) showed a capital epiphysis very irregular in shape and density, but not much flattened. The neck was slightly broadened and very irregular in density. The patient was given crutches and a high sole on the opposite shoe and was directed not to bear weight, a direction that he followed very carefully.

January 6, 1922: All motions of the hip were slightly limited, and the leg was three-eighths of an inch short. Roentgenogram (Fig. 42) showed an epiphysis very irregular in shape and density and considerably flattened, while the neck was broadened.

March 31, 1922: The hip motions were very slightly limited and the leg only one-quarter of an inch short. The roentgenogram (Fig. 43) showed the epiphysis to be less flattened.

June 21, 1922: The hip motions were all free, but the leg was still one-quarter of an inch short. Roentgenogram (Fig. 44) showed the epiphysis to be slightly less flat.

November 27, 1922: All motions of the hip were free except for very slight limitation of abduction. The leg was one-quarter of an inch short. The roentgenogram (Fig. 45) showed an epiphysis more dome-shaped and more regular in density.

April 2, 1923: All motions of the hip were free except for very slight limitation of abduction; the leg was one-quarter of an inch short. The roentgenogram (Fig. 46) showed an epiphysis nearly normal in density and the surface smooth though somewhat flattened. Orders were then given for the patient to continue with crutches and a high sole and no weight-bearing for six weeks more, and then to begin partial weight-bearing with crutches. These were carried out and shortly full weight-bearing was allowed without restrictions (duration of treatment, two years).

December 30, 1933: A final check-up was made ten years after discharge. The patient reported that he had had no symptoms for ten years, although there had been no restrictions in his activities and he had done heavy work, part of the time as a truck driver. Examination showed all motions of the hip as free as on the opposite side, except for very slight limitation of external rotation when the hip was flexed to ninety degrees. The roentgenogram (Fig. 47) showed an epiphysis that was normal except by comparison with the opposite side.

CASE 4 (Figs. 41–47). William H., nine years old. (Illustrations of this case, except the final one, are taken from lantern slides, as the original roentgenograms have been destroyed.)

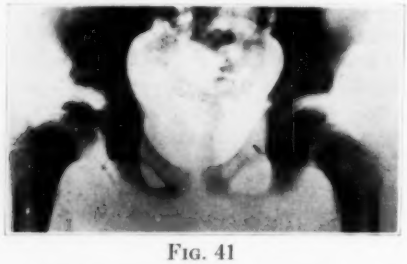

FIG. 41

Roentgenogram, August 4, 1921. Epiphysis very irregular in shape and density, but not much flattened. Neck broadened and very irregular in density.

FIG. 42

Roentgenogram, January 6, 1922. Epiphysis very irregular in shape and density and considerably flattened. Neck broadened.

FIG. 43

Roentgenogram, March 31, 1922. Epiphysis less flattened.

FIG. 44

Roentgenogram, June 21, 1922. Epiphysis slightly less flat.

FIG. 45

Roentgenogram, November 27, 1922. Epiphysis more dome-shaped and more regular in density.

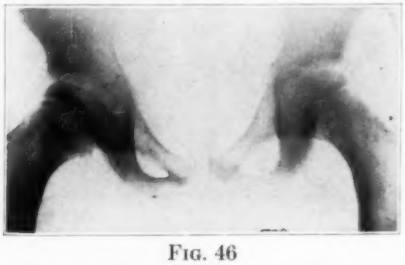

FIG. 46

Roentgenogram, April 2, 1923. Epiphysis nearly normal in density, and surface smooth, though flattened.

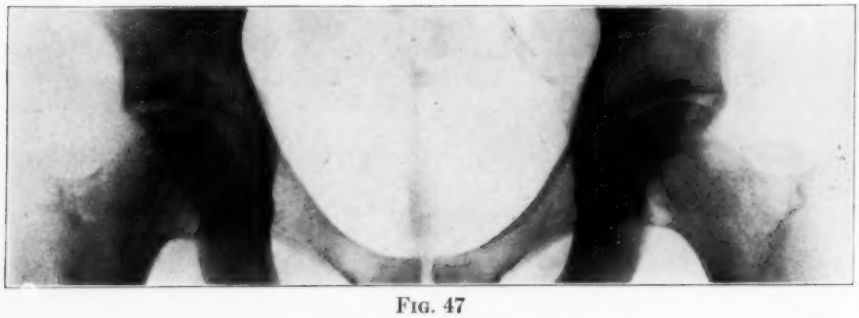

FIG. 47

Roentgenogram, December 30, 1933. Epiphysis nearly normal except by comparison.

CASE 5 (Figs. 48–54). Harold Z., five years old. (The illustrations of this case, except the final one, are made from lantern slides, as the original roentgenograms have been destroyed.)

FIG. 48

Roentgenogram, August 9, 1921. Epiphysis of left femur slightly less dense.

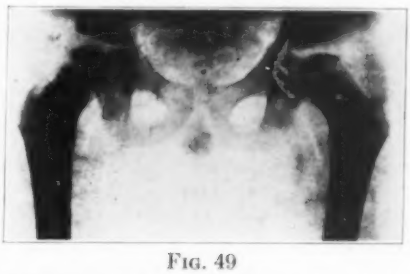

FIG. 49

Roentgenogram, October 11, 1921. Epiphysis slightly smaller and less dense.

FIG. 50

Roentgenogram, January 9, 1922. Some fragmentation of epiphysis with some flattening, also some broadening of the neck.

FIG. 51

Roentgenogram, September 12, 1922. Some fragmentation of epiphysis and irregular density of the neck.

FIG. 52

Roentgenogram, April 19, 1923. Epiphysis has increased in size, but is still irregular in density and flatter than normal.

FIG. 53

Roentgenogram, September 26, 1923. Epiphysis slightly more than normal size, somewhat flattened, but density fairly regular.

FIG. 54

January 4, 1934. Epiphysis almost normal in shape, structure, and position.

CASE 5. Harold Z. was five years old when first seen on August 9, 1921. There had been symptoms in the left leg of five weeks' duration. Examination showed all motions of left hip slightly limited and guarded (sensitive) except flexion which was entirely free. The left leg was one-quarter of an inch short. The roentgenogram (Fig. 48) showed slight lessening of density of the capital epiphysis. The patient was ordered to rest in bed absolutely without weight-bearing.

October 11, 1921: The patient had not been kept in bed, and had used his leg. Examination showed more limitation of all motions and more pain; the leg was three-eighths of an inch short. Roentgenogram (Fig. 49) showed the epiphysis to be slightly smaller and less dense. Again rest in bed was directed.

January 9, 1922: Clinically the hip had not improved and showed all motions markedly limited; there was ten degrees of permanent flexion. The legs were the same length. The roentgenogram (Fig. 50) showed some fragmentation of the epiphysis with some flattening and also some broadening of the neck. Rest in bed was still attempted, but without improvement in symptoms, and hip spicas were finally applied; after seven months the hip was less sensitive. Meantime the boy was kept in bed. Roentgenogram on September 12, 1922 (Fig. 51), showed some fragmentation of the epiphysis and in addition irregular density of the neck. The spicas were continued until December 4, 1922 (about ten months altogether), and then a traction hip splint was applied and the patient became ambulatory, using crutches and with a high sole on the opposite shoe.

April 19, 1923: The patient had worn a traction hip splint for about four months and the motions were more free. The roentgenogram (Fig. 52) showed an epiphysis that had increased in size but was still irregular in density and flatter than normal.

September 26, 1923: The hip motions were only slightly limited and were not sensitive. The leg was one-quarter of an inch short. The roentgenogram (Fig. 53) showed an epiphysis slightly larger than normal and with fairly regular density, but in shape somewhat flattened. The hip splint was continued until December 17, 1923, when partial weight-bearing was allowed; and, from March 25, 1924, full weight-bearing was permitted. This made a period of nearly three years under treatment.

January 4, 1934: About nine years after discharge a final check-up was made that showed no differences between the two hips on clinical examination. The legs measured the same in length and the boy walked and ran without limp and could carry on all his usual activities without restrictions. The roentgenogram (Fig. 54) showed an epiphysis almost normal in shape, structure, and position.

CASE 6. Stuart S. was six years old when first seen, March 26, 1923. He had had symptoms from the left leg of four and one-half months' duration. Examination of left hip showed all motions of the hip slightly limited except flexion which was free. The hip was sensitive. The legs were the same length. The roentgenogram (Fig. 55) showed the left capital epiphysis flattened and irregular in density. The patient was given crutches and a high sole on his opposite shoe and directed to bear absolutely no weight on the affected side.

September 28, 1923: The hip motions were all slightly limited except flexion which was free; all motions were painless. The legs were the same length. The roentgenogram (Fig. 56) showed fragmentation and flattening of the epiphysis and some broadening of the neck of the femur which was irregular in density. Crutches and a high sole were continued.

February 3, 1927: In the interval of three and one-half years the patient did a great deal of weight-bearing, probably even from the first, as it was impossible to get cooperation. Nevertheless all motions of the hip were free except for slight limitation of abduction and hyperextension. The roentgenogram at this time (Fig. 57) showed the epiphysis to be very broad, flat, and thin, and the neck very broad. No further attempt at prevention of weight-bearing was made.

November 21, 1927: Examination showed all motions painless and all free except for slight limitation of abduction and of hyperextension. The leg was only one-eighth of

CASE 6 (Figs. 55–61). Stuart S., six years old.

FIG. 55

Roentgenogram, March 26, 1923. Epiphysis of left femur flattened and irregular in density.

FIG. 57

Roentgenogram, February 3, 1927. Epiphysis very broad, flat, and thin. Neck very broad.

FIG. 56

Roentgenogram, September 28, 1923. Epiphysis shows fragmentation and flattening, and neck of femur is slightly broadened and irregular in density.

FIG. 58

Roentgenogram, November 21, 1927. Epiphysis still broad, flat, and irregular in density. Neck very broad and irregular in density.

FIG. 59

Roentgenogram, December 27, 1928. Epiphysis very flat, broad, and thin. Neck very broad and deformed. Bone structure nearly normal.

FIG. 60

Roentgenogram, February 19, 1930. Head and neck slightly more deformed.

FIG. 61

Roentgenogram, September 17, 1931. Head and neck slightly more deformed.

an inch short and the patient walked without limp. The roentgenogram (Fig. 58) showed an epiphysis that was still flat and broad and irregular in density, and the neck was broad and irregular in density.

December 27, 1928: All motions of the hip were painless and all free except for slight limitation of abduction and hyperextension, necessitating some restriction of activities. Roentgenogram (Fig. 59) showed an epiphysis very flat and broad and thin and the neck broad and deformed. The bone structure, however, was nearly normal, indicating a healed process.

February 19, 1930: All motions of the hip were painless and all free except for slight limitation of abduction and of hyperextension. The leg was five-eighths of an inch short and the patient walked with a slight limp. The roentgenogram (Fig. 60) showed the head and neck a little more deformed.

September 17, 1931: Internal rotation, abduction, and hyperextension of the hip were considerably limited; all motions were painless. The leg was three-quarters of an inch short. He walked with a slight painless limp. The roentgenogram (Fig. 61) showed a little more deformity of the head and neck.

SUMMARY

Cases 1, 2, and 3 illustrate the course and early results in patients treated without apparatus but without weight-bearing. Cases 4 and 5 show the late results of treatment without weight-bearing but with an ambulatory traction splint or with crutches and a high sole. After ten years no deformity had developed. Case 6 illustrates the result where, in spite of directions to the contrary, weight was borne almost constantly.

The illustrations present a plea for non-weight-bearing in Legg-Calvé-Perthes disease until the bone structure has become normal.

THE STATUS OF KOCHER'S METHOD OF REDUCING RECENT ANTERIOR DISLOCATION OF THE SHOULDER*

BY JOSEPH NASH, M.D., F.A.C.S., NEW YORK, N. Y.

Nearly every surgical text gives a different description of the Kocher method. Over twenty years ago Martinet[1] noted the same state of affairs: "The different descriptions do not agree with one another and these descriptions do not correspond with the original description". Therefore, before discussing the opinions held as to its value, it is well to repeat the original description of the method as given by Kocher[2]: "*Pressing the arm, with elbow flexed, close to the side of the body, outward rotation until a resistance is encountered, elevation forward of the externally rotated arm in the sagittal plane as far as it will go, and finally slow inward rotation.*" This is the Kocher method, and it was intended for use only in *recent anterior* dislocations of the shoulder. The following discussion will be confined to its use in connection with this one type of case, although Kocher later considered the method applicable to old dislocations as well. (In one case of dislocation of eight weeks' duration in a man of seventy-nine years, Kocher induced fracture of the shaft of the humerus; in twelve cases, in which the duration of the dislocation ranged from three weeks to four months, he accomplished reduction successfully.) It should be noted that Kocher does *not* prescribe traction as part of his method. He does not even mention traction in connection with it.

Table I contains a list of fifteen authors who decidedly favor the original Kocher method. Kaufmann, Bach, and Ceppi were pupils of Kocher and perhaps Kaufmann's phenomenal success with the method (only three failures in 300 cases during forty-seven years) is attributable to special skill acquired under the guidance of the inventor. It is noted that several writers who favor the method disagree with its author as to the relative importance of muscles and capsule in opposing reduction, and as to the frequency of complicating fracture of the greater tubercle.

That the original method did not prove entirely satisfactory is indicated by the fact that modifications (Table II) were suggested, consisting mainly in the addition of the recumbent posture, traction throughout the procedure, and overadduction of the arm, so as to carry the elbow across the front of the chest to the mid-sternal line.

In Table III are listed six writers who reject the method, with their reasons for doing so. From the fact that this list is short, one might think that the profession in general has found the method very satisfactory. However, from a fairly complete survey of the literature, the writer finds that forty-six "new" methods for reducing a dislocated shoulder have been proposed since Kocher's first publication on the sub-

*From the Department of Surgery, New York University, and the Third Surgical Division, Bellevue Hospital.

TABLE I

AUTHORS WHO ACCEPT KOCHER'S METHOD

Year	Author	No. of Cases	Remarks
1881	C. Kaufmann	14	Pupil of Kocher.
1882	*Körte	Not stated	Fracture of greater tubercle more frequent than Kocher believed.
1883	Heath	5	Chloroform given in three cases.
1885	Stimson	Not stated	"Appears well adapted to avoid the dangers to the vessels."
1888	Norton	11	Unsuccessful in one other case.
1889	Boerstler	1	
1890	*Hennequin	Not stated	Muscles are as important as is capsule as obstacle to reduction.
1890	Beesley	2	
1898	*Waterston	Not stated	Muscles are important, not coracohumeral band.
1906	Faucon	11	Unsuccessful in two other cases.
1906	Bach	Not stated	Cadaver study under direction of Kocher.
1909	Battle	1	Successful, but tearing of axillary vein resulted in death.
1924	Schlaepfer	113	Kocher's method "usually satisfactory".
1926	*C. Kaufmann	300 (in forty-seven years)	Fracture of greater tubercle is more frequent and the capsular tear is usually greater than Kocher supposed. Only failed in three cases. Pupil of Kocher.
1927	Ceppi	Not stated	Pupil of Kocher.
1927	Roux	Not stated	Succeeds only in strictly subcoracoid cases.

* Differs with Kocher as to rationale.

TABLE II

AUTHORS WHO MODIFY KOCHER'S METHOD

Year	Author	No. of Cases	Modification	Remarks
1883	Jersey	20	Traction.	
1889	Powers	98	Recumbent position and traction.	Failed in twenty-eight other cases. Muscles hinder reduction.
1891	Woolmer	1	Elbow carried across front of chest.	
1891	Honan	2	Recumbent.	
1893	Thomas	24	Recumbent, traction, elbow carried in across chest.	Six other cases failed.
1894	Morton	Not stated	Recumbent, elbow carried in across chest.	
1895	Mermet	Not stated	Recumbent.	Pain and syncope frequent.
1898	Boyd	Not stated	Recumbent.	
1906	Robineau	Not stated	Elbow carried in across chest.	
1910	Gallois	Not stated	Patient's hand on surgeon's shoulder, elbow carried in across front of chest, last step done very slowly.	In practice, Kocher's method usually fails and then the ancient method of traction is used.
1910	Delorme	Not stated	Traction.	Contrary to Kocher, does not believe anterior part of capsule opposes reduction.
1927	Best	Not stated	Traction.	

TABLE III

AUTHORS WHO REJECT KOCHER'S METHOD

Year	Author	Remarks
1903	Vaughn	Very painful, danger of injury to tissues.
1910	Martinet	Painful. "The different descriptions do not agree with one another. . . . These descriptions do not correspond with the classical description. . . . A procedure difficult to apply, whose indications are very restricted, and which is uncertain and dangerous."
1918	Cosens	Painful. Frequently fails.
1919	Constantini	Fails too often, even in the hands of the most expert. Is too complex.
1928	Meyer	Danger of causing fracture is too great.
1930	Rixford	Danger of causing fracture, saw several such instances, one his own.

ject,—that is, between 1870 and 1926 (Table IV). Twenty of these methods involve traction outward; eight, downward; and seven, upward. The remaining eleven methods do not involve traction,—six of them consist essentially of adduction of the arm over a fulcrum, and five belong to a class which might be described as "trick" methods. It is likely that if Kocher's method had been found highly effective there would not have been so many attempts to find a substitute for it.

Kocher indicates that at the time he proposed his method his personal clinical experience with dislocation of the shoulder was limited to eleven cases, in less than half of which he had employed his new procedure. In the experimental investigations on which the method is based, he undertook to produce a "typical" dislocation by deliberately incising the joint capsule at a particular part and to a definite extent, and then dislocating the humeral head by means of a manoeuver obviously adapted to this incision. "An incision was made in the axilla over the head of the humerus parallel with the anatomical neck, opening the capsule from the lower border of the subscapularis to the origin of the triceps. The arm was then forcibly raised to the vertical and pushed downward. On lowering it I found a complete subcoracoid dislocation." He then determines from the dissected part what sort of manipulation is required to replace the bone after it has been artificially displaced in this manner. It should be emphasized that Kocher bases his method entirely on this type of experiment.

Kocher assumes that the tear in the capsule is practically always in the antero-inferior part of the joint, while the other parts remain intact, for both his experiments and his proposed method rest upon this assumption. Most writers of the present time seem to make the same supposition. In a fairly complete search of the literature since 1880, the writer has found eight autopsy reports of cases of dislocated shoulder in which the damage to the capsule is clearly stated[3]. The tear was antero-inferior in only three cases. In two cases, it was anterosuperior (in one of these cases the humeral head did not protrude through the small tear); and there was no tear at all in the remaining three cases, although in one of

TABLE IV

"NEW METHODS" OF REDUCING DISLOCATION OF THE SHOULDER PROPOSED SINCE 1870

Essential Feature of Method									
Lateral Traction		Downward Traction		Upward Traction		Adduction Over a Fulcrum (No Traction)		"Trick" Methods (No Traction)	
Author	*Date*	*Author*	*Date*	*Author*	*Date*	*Author*	*Date*	*Author*	*Date*
Despres	1877	Jones	1879	Chenowith	1883	Purdy	1888	Greene	1881
Lawton	1881	Cole	1891	Huguier	1905	Hallaran	1895	Hussey	1887
Hicks	1881	Brennsohn	1903	Chipman	1906	Ferrier	1895	Michie	1887
Macphail	1881	Garms	1905	Caesar	1914	Wagner	1911	Marcille	1913
Macleod	1882	Spitzy	1916	Angelvin	1915	Bentzon	1921	Newton	1926
Kelly	1882	Turner	1918	Cosens	1918	Newton	1926		
Longfield	1887	Haller	1919	Malis	1924				
Parkinson	1887	Constantini	1919						
Lloyd	1887								
Owen	1887								
Dutch	1887								
White	1891								
Berthaut	1905								
Rapoutova	1906								
Marion	1906								
Schickhold	1909								
Doyen	1911								
Barbet	1918								
Dshanilidze	1924								
Stevens	1926								

these cases the capsule was detached from the anterior glenoid edge, but was still continuous with the periosteum of the scapula. These findings indicate that assumptions as to the exact nature and location of the injury to the capsule in a given case of dislocation of the shoulder may not be as well founded as Kocher and others have supposed.

Under the conditions of his experiment, Kocher finds that "the undamaged upper part of the anterior wall of the capsule, the part attached to the upper edge of the tendon of the subscapularis muscle and lying between the latter and the biceps tendon, undergoes a rotation and is turned into a cord which runs diagonally from the upper edge of the glenoid attachment of the capsule to the lower humeral attachment, passing beneath the tendon of the subscapularis and in part blending with the upper edge of the latter. This relation of the anterosuperior part of the capsule I have found constantly, and it is to be assumed that this condition is the rule." On this assumption, Kocher assigns an important rôle to the portion of the capsule in question in his proposed method of reduction. "The first step, in which the arm is drawn to the side of the body, causes the superior part of the capsule to become stretched still tighter than it was so that a firmer fulcrum point is gained, about which the head can be rotated outward. By this outward rotation the posterior wall of the capsule, which is continuous with the cord, is elevated off the glenoid, and there is no other method by which this might be accomplished so effectively,—*i. e.*, by which the tear in the capsule might be made to gape so widely."

The belief that the strong upper part of the capsule (coracohumeral ligament) always remains intact in clinical dislocation has been questioned. Schüller[4] expresses a view just contrary to that of Kocher: "The capsular tear in by far the majority of typical luxations is so large that difficulty of reduction can in no way be due to it." Kaufmann[5], pupil of Kocher and a staunch apostle of his method since 1881, states: "Kocher had supposed that the upper part of the joint capsule remained intact. This supposition was not subsequently confirmed. We know that tearing of the ligamentum coracohumerale is possible even without damage to the tuberculum majus, and then it escapes x-ray diagnosis." Although he continues to advocate the method, Kaufmann is forced to speculate anew as to its rationale as far as the damage to the capsule is concerned.

The coracohumeral ligament is inserted into the front of the greater tubercle of the humerus, and so is almost certain to suffer injury or relaxation whenever the tubercle is fractured. Then the mechanism of reduction described by Kocher would be impossible. Evidence that fracture of the greater tubercle is rather frequent in dislocation of the shoulder will be given presently.

It is a fundamental postulate of the rationale of the Kocher method that reduction can be attained as well without relaxation of the muscles as otherwise. Kocher cites earlier studies by various investigators as to the relative importance of the joint capsule and the muscles in opposing re-

duction, and, in the face of conflicting evidence and opinions, adopts the following tenet: "In spite of all, it remains a valid principle in dislocation of the shoulder that reduction can be accomplished through relaxation of the stretched remainder of the capsule and opening up of the tear in the capsule, even without relaxation of the muscles." From his observations on the cadaver he proceeds to describe in detail which muscles are stretched and which are relaxed in a dislocation of the shoulder; and implies that the same conditions obtain in the living, since he professedly bases his clinical method upon his experimental studies.

Hennequin[6], a proponent of the Kocher method, states: "The facts of practical surgery are a puissant argument in favor of the muscular theory, for anaesthetics paralyze the muscles but have no action on the ligaments. . . . Experiments on the cadaver can never supersede clinical facts when there is a question of lesions in which the muscles cannot remain inactive." Dagron[7], holding that "muscular contraction is the sole cause of the hindrance to the return of the head into the glenoid cavity", recommends massage for inducing relaxation. Saquet[8] reports a case in which reduction occurred under the influence of massage applied ten minutes after the accident with the object of easing the pain.

Kocher accords the deltoid muscle special mention, as follows: "Regarding the deltoid muscle, a peculiarity deserves attention which, as far as I know, has not hitherto been appreciated by anatomists. If one studies anew the deltoid in subcoracoid dislocations in the living or on the cadaver, one finds springing from the most lateral part of the acromion a rounded cord extending to the insertion in the arm, which is more tense than all the other parts of the muscle. This cord appears in the preparation as a rounded tendon running in the muscle, lying on its inner surface, which can be isolated without any difficulty. It is clear that one might take it for the displaced biceps tendon in the living if one does not follow it to its insertion. . . . It is obvious that the deltoid . . . in determining the difficulty of reduction is of interest first because of its fibrous component and second on account of its muscle fibers." He asserts that "there can be no question but that it [the tendinous cord] by its tension, and in conjunction with the capsule, aids in holding the [dislocated] head of the bone against the anterior edge of the glenoid".

A strong inelastic tendon, completely traversing the length of a muscle and fastened both to the origin and to the insertion would appear to be a very exceptional arrangement, hardly consistent with the normal functioning of a skeletal muscle. Because of the clinical importance attributed to it by Kocher, this anatomical finding has been reexamined. Gray's Anatomy (1930) describes "tendinous intersections, generally four in number" but does not state that these traverse the entire length of the muscle. The writer, on dissecting sixty deltoid muscles in thirty adult subjects, found that the tendinous cords of origin varied in number (from two to five) and in thickness with the muscular development of the subject, but that in every instance, when traced dis-

tally, they became narrower and completely disappeared in the substance of the muscle, none reaching the tendon of insertion. These findings do not support Kocher's statement that a tendinous component of the deltoid muscle is of importance in opposing reduction.

Kocher's manoeuver requires an "impingement of the greater tubercle or of the posterior part of the anatomical neck against the anterior glenoid edge". As this impingement is interfered with if the part is fractured, Kocher places fracture of the greater tubercle among the contra-indications to his method, and states: "The question as to the frequency of avulsion of the greater tubercle is of importance in the mechanism of reduction." As direct evidence that this complicating fracture is usually absent, he cites three autopsy reports from the literature and Malgaigne's statement (based on a few autopsies) that "as a rule" it is absent. It is generally believed that fracture of the greater tubercle complicates dislocation of the shoulder in only a small minority of cases, but this is not the case. Gubler[9] finds fracture of the greater tubercle in seven per cent. of cases of dislocated shoulder. Schlaepfer[10] finds it in seven and four-tenths per cent. of 114 cases observed between 1899 and 1919, the diagnosis being made, no doubt, without roentgenographic aid in the earlier cases. Meyer[11] gives fourteen per cent. without stating the evidence supporting that figure. The greater tubercle is fractured in "most dissected cases" according to Körte[3]; "in over half of all cases" according to Bardenhauer[12]. Kaufmann[5], faithful disciple of Kocher and ardent protagonist of his method, concedes that "x-ray studies have established the great frequency of damage to the tubercle".

Thirteen post-mortem reports[13] found in the literature since 1880 are explicit on this point. An associated incomplete fracture of the humerus was found in ten cases. In four of these cases the fracture was at the anatomical neck or articular cartilage. In six cases the greater tubercle was affected,—being merely chipped in one case, more extensively fractured in two cases, and completely torn off in three cases.

On the Third Surgical Division of Bellevue Hospital, 127 cases of primary recent anterior dislocation of the shoulder were treated during the ten-year period 1922–1931, inclusive. In twenty-eight cases, or twenty-two per cent., fracture of the greater tubercle of the humerus was found on roentgenographic examination. It is of interest that in five cases the first roentgenogram, taken with the portable ward machine, failed to reveal the fracture, which was detected only on subsequent examination in the x-ray department under more favorable conditions. The average age of the entire group was fifty-two and eight-tenths years; of those with fracture of the tubercle, forty-eight and nine-tenths years. (In addition, there were ten cases of recurrent dislocation in which there was no associated fracture.)

Kocher seeks to establish the rarity of fracture of the greater tubercle by indulging in the following "logic": "Since [major premise] healing of

the greater tubercle is usually imperfect, while [minor premise] residual impairments of function after dislocations of the shoulder are nevertheless rather exceptional, we may conclude that dislocation is in most cases uncomplicated by this fracture." Aside from the gross technical errors exhibited in this syllogism, it may be said that the substance of the major premise has not been confirmed; in fact, over fifty years later, a representative textbook of surgery[14] states concerning fractures of the greater tubercle of the humerus: "Satisfactory healing usually occurs". And, contrary to the minor premise, the same textbook states that permanent disability, following shoulder dislocation, is frequent. That Kocher did not encounter fracture of the tubercle in his cadaver experiments is not surprising considering the stereotyped incision and rather gentle manipulation by which he induced dislocation, and the absence of muscular action in the dead subject.

In modern practice, in whatever method is selected, the use of some form of traction for the reduction of a dislocated shoulder is nearly universal, and is the chief requisite. Traction is employed in the treatment of fractures and dislocations to "fatigue the muscles", according to current teaching, which ignores the known physiological mechanisms which regulate the tonus of skeletal muscle. In a tonically contracted muscle, the various muscle fibers act in rotation, intermittently and asynchronously. Hence, fatigue is markedly delayed because one group of fibers can rest while the neighboring fibers are contracting.

The tone of striated muscle is neurogenic,—that is, it depends entirely upon stimuli coming to the muscle from the central nervous system; and it is reflex in that the nerve centers emit the tonic impulses in response to afferent impulses coming into the centers along afferent nerve fibers. One source of these afferent impulses is the sensory muscle spindles in the muscles themselves, stimulation of which by traction reflexly induces shortening or lengthening of the muscle. The application of a small pull to an innervated muscle excites it to resist the pull (shortening reaction). The application of a considerable pull, especially if continued for some time, stimulates a different set of sensory receptors in the muscle, which results in reflex inhibition in the tonus of the muscle (lengthening reaction). Muscle spindles have been found to continue to discharge a regular series of afferent impulses in response to a prolonged unvarying stimulus, such as is produced by steady traction. In this respect they differ from other sensory end organs, such as those of touch, which show only a transient response (as measured by action currents) to a continued stimulus,—that is, those which suffer more rapid adaptation to the stimulus.

In reducing a dislocated shoulder one would do well to give careful consideration to the known physiological functions of the proprioceptive system, and not to confine his attention entirely to the purely structural aspects of the condition.

SUMMARY AND CONCLUSION

A study of the literature reveals that many authors reject Kocher's method entirely, many more advise various "modifications", and a still larger number have offered new methods of reduction, most of them involving traction. Clinical, roentgenographic, and autopsy evidence does not support Kocher's beliefs as to the rôle played by the muscles, the capsule, and the greater tubercle of the humerus in dislocation of the shoulder. Kocher's method for reducing dislocation of the shoulder may well be omitted from the textbooks and more physiological methods substituted.

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TUBERCULOSIS OF THE SHAFT OF THE LARGE LONG BONES OF THE EXTREMITIES

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Tuberculosis of the shaft * of the large long bones of the extremities is reported by others as a lesion rare in Occidentals. Attention has not been called previously to its more frequent occurrence among the Chinese. During the past twelve years (1921–1932), thirty-eight patients with tuberculosis of the shaft of the long bones have been seen in this Hospital. These thirty-eight cases represent 4.8 per cent.† of a total of 786 cases of bone and joint tuberculosis treated during this time.

Because of insufficient data, twelve of the thirty-eight cases are not included in this report. Of the remaining twenty-six cases, twenty have been studied by the writers and form the basis of this paper. Six of the earlier cases have been described in a separate communication.‡

PATHOGENESIS

Various types of tuberculous involvement of the shaft of the long bones have been described, such as: (1) the periosteal form (Von Friedländer, Allison); (2) the solitary metaphyseal focus, a circumscribed low-grade lesion of the central portion of the bone, similar to the Brodie's abscess of pyogenic osteomyelitis (Von Friedländer, Zumsteeg, Sorrel and Sorrel-Déjerine, Lovett and Wolbach); and (3) the infiltrative lesion which may involve a portion, or even all, of the shaft of the bone (Koenig, Gralka and others). Most frequently, the infiltrative lesion includes from one-fourth to one-half of the length of the shaft. In rare instances, however, the entire shaft may be involved and may show multiple cystic areas scattered throughout the medullary and cortical bone, similar to the "Jüngling" type found in the "short" long bones (Van Alstyne and Gowen), or an osteitis with mixed sclerotic and rarefying lesions

* The term "shaft tuberculosis", as used by Hildebrandt, Zumsteeg, and Caan, includes lesions originating in the diaphysis and metaphysis and excludes lesions of the shaft of the bone which represent an extension of the disease from the epiphysis or from the joint. The writers prefer this definition and have included in their reports only those cases which come under this category.

† The relatively high percentage of this form of lesion among the Chinese is apparent when a comparison is made between this figure and figures from other clinics, which vary between 0.8 per cent. (Kuettner) and 0.9 per cent. (Zumsteeg). One of the writers (L. J. M.) found four cases in a total of 1,000 cases of bone and joint tuberculosis treated in Steindler's clinic (0.4 per cent.). According to Caan, the figures of Schiftan and Karewski (4 per cent.) and Scheimflug (11 per cent.) are probably incorrect, since these authors included in their statistics not only the primary processes of the shaft, but also those secondary to tuberculosis of the epiphysis.

‡ The article by Dr. G. W. VanGorder appeared in the April issue of this *Journal*. See Bibliography.

(Schinz) which are spread out in multiple foci over the shaft without involvement of the epiphyses and joints.

From the variety of these types, it is apparent that in most respects tuberculous lesions of the shaft may simulate the osteomyelitic lesions produced by pyogenic bacteria, and, therefore, it is believed that the mode of infection is the same in either condition. Koenig first emphasized the embolic theory of skeletal tuberculosis. He believed that tubercle bacilli, entering the bone by way of the blood stream, are stopped at a narrow or terminal portion of a capillary and that a tubercle results. In 1904, Lexer showed that the capillaries of the epiphyseal, metaphyseal, and diaphyseal blood vessels in young individuals do not anastomose, and, therefore, are end vessels. The finer ramifications of the blood vessels in each of these regions are directed toward the epiphyses, and this explains partially the usual location of the primary foci in tuberculous infections of the shaft. The actual point of localization is determined by the relationship between the size of the infecting embolus and the size of the blood vessel in which it becomes lodged.

The position of the embolus, or thrombus, with respect to the main nutrient vessel, the virulence of the bacilli, and the resistance of the local tissues are all factors which help to determine the nature of the lesion. The dominant characteristics of the pathological picture are: (1) thromboarteritis or thrombo-phlebitis; and (2) necrosis of the bone cells consequent to the disturbance of the circulation. According to Fraser, the extent of the lesion depends for the most part upon the second factor. If a tuberculous embolus becomes lodged, or if a thrombus forms in the nutrient artery before its division into primary branches, the thrombosis may spread widely throughout the entire intra-osseous vascular network and the disturbance of the blood supply for the given bone becomes maximum in degree. If infection spreads throughout the whole area of impaired circulation, necrosis of the entire diaphysis may follow. The periosteal circulation remains undisturbed except for a physiological dilatation of the blood vessels secondary to the underlying infection; therefore, the formation of involucrum is usually quite active. When thrombosis occurs in one of the primary branches of the nutrient vessel, the extent of the lesion depends upon the degree of intra-osseous clotting and infection, and upon the efficacy of the collateral circulation, especially that part which comes by way of the periosteal blood vessels. Following a spreading infection in this location, one-fourth, or even one-half, of the shaft may be involved. When the infected embolus is arrested in one of the terminal branches of the nutrient or metaphyseal arteries, only a small area of necrosis may follow. If the virulence of the organisms is low, the condition may persist as a circumscribed chronic bone abscess; on the other hand, if the virulence is high, the local lesion may extend directly to involve the medullary portions of the bone in the immediate neighborhood, or may spread into the epiphysis and finally reach the joint.

In excellent studies of the microscopic pathology of shaft tuberculosis, Fraser, Allison, and Lovett and Wolbach have each emphasized the facts that the tubercle bacillus can duplicate the reaction of almost any type of pathogenic bacterium, and that in tuberculosis of the bone, as in tuberculosis of the soft tissues, there may occur: (1) an exudate, fibrinous or puriform; (2) discrete proliferative tubercles which may progress slowly or rapidly with much or little caseation; and (3) a diffuse proliferative reaction (tuberculous granulation tissue) with much or little caseation. These writers agree that, in most forms of shaft tuberculosis, the lesions are usually characterized by the destruction of bone, but that in certain instances there may be a marked tendency to the proliferation of bone. Allison states that "we should not lose sight of the fact that tuberculous lesions behave in a manner directed by the tissue reaction to infectious processes. When the tubercle bacillus invades tissues which in their reaction to infection readily produce new bone, the lesion observed has as one of its characteristics *new bone formation*." Consequently, when cancellous bone is involved, destruction predominates, and, when the periosteum is involved, proliferation takes place.

REPORT OF CASES

CASE 1. A Chinese woman, aged thirty-seven years, was admitted to the Hospital because of chronic pain, distributed irregularly over the entire body. Several days before admission, the pain became so severe that the patient was forced to stay in bed.

Entrance examination revealed the presence of generalized osteomalacia and minimal pulmonary tuberculosis (not active).

Roentgenograms showed that the pelvis was heart-shaped; there were also multiple fractures of the ribs and of the os pubis. There was a definite formation of new bone beneath the periosteum of the middle portion of the shaft of the right tibia on its anterior surface (Fig. 1). This lesion appeared not unlike syphilitic periostitis.

After complete metabolic studies had been made, the diagnosis of osteomalacia was confirmed. The blood contained a normal amount of calcium. There were, however, three milligrams of phosphorus per 100 cubic centimeters of blood,—slightly less than normal.

An exploratory operation was performed on the tibia. By means of an Albee saw, a piece of the periosteum, cortex, and the underlying medullary bone was removed from the involved area. Microscopic examination of sections of these tissues showed definite evidence of tuberculous infection of the periosteum and superficial layers of the cortex (osteitis) without involvement of the deeper layers of the cortex or of the medullary bone. The patient received the routine conservative treatment for osteomalacia and gradual improvement was noted. Within a short period of time, the generalized pain in the muscles disappeared and the fractures healed promptly.

Six months after the operation, follow-up roentgenograms of the right tibia showed no marked changes. There was no evidence of extension of the periostitis or of abscess formation. A slight swelling persisted over the involved region of the tibia.

Allison and Fisher believe that this type of tuberculosis forms a distinct clinical entity. These writers have described lesions that developed in dogs when the subperiosteal region of the long bones was infected with tubercle bacilli. These lesions remained limited to the subperiosteal region and did not extend into the deeper portions of the underlying cortex and cancellous bone.

FIG. 1

Roentgenogram of Case 1, showing the form of tuberculous lesion designated as Type I. Note the proliferation of periosteum in the middle third of the right tibia, most marked over the anterior cortex. The periosteal new bone is rarefied and irregular. The underlying cortex shows slight rarefaction. The roentgenographic diagnosis was syphilitic periostitis. This patient also had generalized osteomalacia.

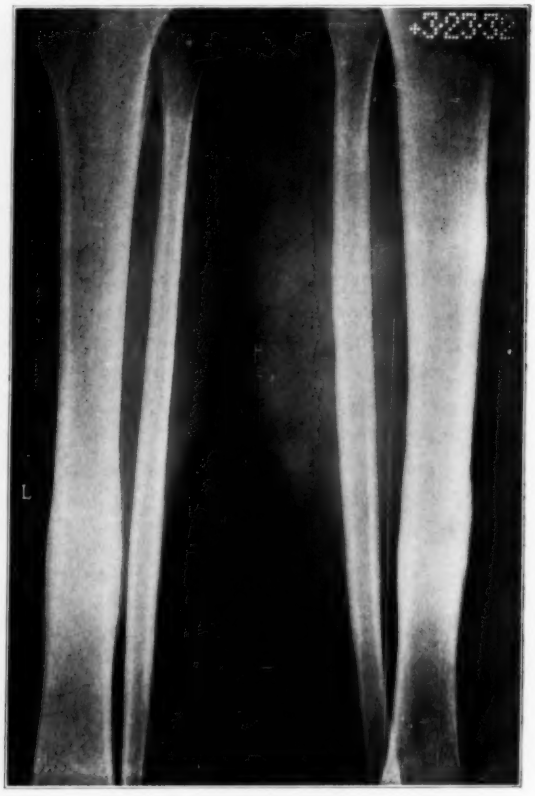

FIG. 2

Roentgenogram of Case 11, showing another instance of a tuberculous lesion of the periosteal type. Note that this lesion is similar to the one shown in Fig. 1. There is dense periosteal new bone around the shaft of the left tibia at the junction of the middle and distal thirds, without rarefaction.

CASE 2. A Chinese male, aged twenty-one years, was admitted to the Hospital because of a painful swelling of six months' duration in the right lower forearm. One month after the onset the swelling ruptured and a discharge of pus was still present at the time of admission.

The general physical examination was essentially negative except for the surgical condition.

Roentgenograms showed a large oval-shaped abscess in the distal end of the diaphysis of the right radius, with rarefaction and thickening of the cortex and irregular proliferation of the periosteum involving the entire distal third of the shaft. There was marked absorption of the cortical bone.

An exploratory operation was performed. The bone was saucerized and a sequestrum was removed from the abscess. Since secondary infection was present, the wound was treated by Orr's method. Specimens of bone and soft tissue removed at the operation showed evidence of tuberculosis.

The infection of the bone became quiescent seven months after operation and at

that time the sinus had healed completely. In a follow-up letter, written one year later, the patient stated that his health was good and that there was no evidence of recurrence of the infection in the bone.

CASE 3. A Chinese girl, aged seven years, gave a history of chronic pain and swelling of two years' duration in the left lower thigh.

Entrance examination showed essentially normal findings except for the surgical condition. There was a large swelling over the distal third of the shaft of the femur, extending to the left knee.

Roentgenograms showed extensive destruction of bone of the distal end of the shaft of the femur, and evidence also of an extension of the infection into the region of the epiphysis.

At exploratory operation, the abscess cavity in the bone was unroofed and packed loosely with gauze which had been impregnated with iodoform powder. The wound was closed partially with catgut sutures. Specimens of bone and soft tissue showed evidence of tuberculosis. The patient received postoperative treatment, consisting of rest in bed and immobilization of the affected extremity, despite which the infection extended into the knee joint.

Follow-up examination one year later showed that the tuberculous lesion of the femur was quiescent. There was no evidence of tuberculosis of the lungs or other viscera.

CASE 4. A Chinese male, aged forty years, complained of pain and swelling of a year's duration over the upper portion of the right arm. Two months after the onset, the swelling was opened by a native physician, following which the wound drained continuously. A sinus was present at the time of admission.

Entrance examination revealed generalized lymphadenitis, chronic suppurative otitis media with mastoiditis, and ascariasis.

Roentgenograms showed irregular destruction of the proximal third of the shaft of the right humerus, with erosion of the cortex and proliferation of the periosteum. Because of the extension of secondary (pyogenic) infection into the right shoulder joint, the upper third of the shaft and the head of the right humerus were resected. Specimens of bone and soft tissue showed evidence of tuberculosis. The usual conservative treatment was used following the operation. Several weeks later, the patient's general condition was greatly improved and he was allowed to go home. The follow-up is incomplete.

CASE 5. A Chinese woman, aged thirty-three years, was admitted to the Hospital because of recurrent hemoptysis, loss of weight, fever, and chronic swelling, with a discharging sinus over the upper portion of the left leg.

Physical and roentgenographic examinations showed evidence of active pulmonary tuberculosis involving both upper areas. Roentgenograms of the left leg showed a small central area of destruction in the proximal third of the shaft of the tibia.

The usual conservative treatment was instituted for the pulmonary condition, and, under spinal anaesthesia, an unroofing operation was performed on the lesion in the left tibia. A definite abscess containing cheesy material was found. Specimens of bone and soft tissue showed microscopic evidence of tuberculosis. Since the abscess was infected with pyogenic organisms, the Orr treatment was used.

Three months after operation, the wound of the tibia had healed, and there was no roentgenographic evidence of extension of the infection. At that time the patient's pulmonary condition was definitely improved. Reexamination, six months after operation, showed that the bone lesion was quiescent.

CASE 6. A Chinese male, aged nineteen years, first noticed a painful swelling in the left lower forearm six months previous to admission. Four months after the onset, the swelling ruptured spontaneously, with a discharge of thin, yellow, purulent material.

Shortly after this, a painful swelling developed in the left axillary region and ruptured with a purulent discharge.

Entrance examination showed normal findings except for the condition of the bone and the axillary lymphadenitis which was thought to be tuberculous in nature.

Roentgenograms showed a definitely circumscribed central abscess in the distal third of the shaft of the radius. There was no evidence of infection in the distal epiphysis or in the wrist joint.

Shortly after admission, the sinus leading to the radius was excised, a sequestrum removed, and the abscess cavity saucerized. Since secondary infection was present, the wound was left wide open, vaselin gauze dressings were inserted, and a cast was applied according to the technique of Orr. Specimens of bone and soft tissue removed at the time of operation showed microscopic evidence of tuberculosis.

Approximately eight months after operation, the wound was healed and the patient noticed a gradual return of the function of the left wrist and hand. Two years after the operation a small painless swelling appeared in the region of the old operative scar. At that time, follow-up roentgenograms showed definite evidence of renewed activity of the lesion. Further surgical treatment was advised, but was refused by the patient.

Case 7. A Chinese girl, aged eleven years, came to the Hospital because of a painful swelling of one and one-half months' duration in the middle portion of the right leg. Two weeks prior to admission, the swelling had ruptured, with a discharge of pus.

The general physical and roentgenographic examinations at the time of admission showed evidence of active tuberculosis of the root of the lung and the adjacent pulmonary parenchyma; there was also an area of central destruction in the middle and distal thirds of the shaft of the right tibia, with rarefied thickening of the cortex and proliferation of the periosteum.

One week after admission, an unroofing operation was performed on the tibia, after which Orr's treatment was carried out. Specimens of bone and soft tissue removed from the diseased area showed microscopic evidence of tuberculosis. In spite of prolonged conservative treatment, the operative wound failed to heal.

Two and a half years after operation, a draining sinus was still present. Roentgenograms at that time showed an area of radiotransparency, which was larger than that seen in previous follow-up films. The edges of the diseased area of bone appeared hazy and irregular, suggestive of renewed activity. The pulmonary disease was still active. Further treatment was advised, but was refused by the patient.

Case 8. A Chinese girl, aged nineteen years, came to the Hospital because of a painful swelling over the upper third of the right leg. A bilateral pulmonary tuberculosis was present.

Roentgenographic examination also showed marked thickening of the cortex of the entire proximal third of the shaft of the right tibia distal to the level of the tuberosity. The thickened cortex was rarefied, and there was a moderate amount of proliferation of the periosteum which was distinct from the involved cortex.

The patient received the usual conservative treatment for the pulmonary lesion.

A short time after admission an exploratory operation was performed on the right tibia. Considerable caseous material was found beneath the periosteum and in the deeper portions of the lesion in the cancellous bone. Small sequestra were removed and the bone was saucerized. Microscopic examination of tissues removed at operation showed evidence of tuberculosis. The usual conservative treatment was given, but the patient grew worse steadily.

Approximately one year after operation, the pulmonary lesions had extended considerably and the local bone lesion showed slight extension. There is no further record.

Case 9. A Chinese male, aged thirty-two years, was admitted to the Hospital because of a painful swelling and a discharging sinus of two years' duration in the proximal third of the left leg.

Moderately active pulmonary tuberculosis, involving both upper lungs, was found.

FIG. 3

Roentgenogram of Case 13, showing the form of lesion designated as Type II. A large oval cavity is located in the proximal cancellous portion of the tibia, two centimeters below the epiphyseal line. The area of destruction is well defined, except at its inferior lateral margin where the outline is indistinct. A small sequestrum is present in the cavity. The surrounding zone shows moderate condensation and irregular rarefaction. A small amount of rarefied periosteal new bone is seen.

FIG. 4

Lateral view of the same case shown in Fig. 3. The abscess cavity is less distinct, but the condensation of the anterior cortex is more evident. Minute scattered areas of erosion of the cortex may be seen.

FIG. 5

Roentgenogram of Case 20, showing another tuberculous lesion belonging to Type II. Note the large, localized area of destruction with several sequestra in the distal portion of the tibia. The medial cortex is included in the abscess. There are diffuse condensation and scattered small areas of erosion in the surrounding bone. The distal articular surface of the bone is intact.

There was a localized abscess cavity in the upper third of the shaft of the left tibia just below the tubercle.

Conservative treatment for the pulmonary tuberculosis was instituted and, under spinal anaesthesia, an unroofing operation was performed on the affected bone. The cavity contained caseous material and also several small sequestra. As much as possible of the diseased bone and soft tissue was excised. Microscopic examination of these tissues showed evidence of tuberculosis.

One year later, follow-up examination revealed a very small discharging sinus in the region of the old operative scar. Roentgenograms showed that the lesion in the bone had become quiescent. The function of the knee joint was quite satisfactory. The condition of the lungs had improved.

CASE 10. A Chinese boy, aged five years, was admitted to the Hospital because of pain and swelling of thirteen months' duration in the right lower leg. Eleven months prior to admission, the swelling ruptured, with a discharge of purulent material. Two months later, another sinus developed near by. On admission both sinuses showed a discharge of purulent material.

Physical and roentgenographic examinations showed essentially normal findings except for the lesion of the tibia. There was a circumscribed abscess of the bone (similar to the Brodie's variety) about two centimeters above the epiphyseal line. There was a slight extension into the epiphysis.

An unroofing operation was performed and definite evidence of tuberculosis was seen in the bone and soft tissue which was removed. The wound had healed completely four months later.

On examination two years later, the patient was found to be in good health and the tuberculous infection of the bone was quiescent.

CASE 11. A Chinese woman, aged twenty-seven years, came to the Hospital because of painful swellings with draining sinuses over the right forearm and left leg. Both of these swellings had been present for approximately one year previous to admission. The patient's general health was poor.

Physical and roentgenographic examinations revealed moderately advanced pulmonary tuberculosis of the upper areas of both lungs. Roentgenograms showed a thickening of the cortex and periosteum in the mid-portion of the shaft of the left tibia. In the distal fourth of the shaft of the right ulna, there was a definite area of destruction of the cortex and medulla for a distance of about two and five-tenths centimeters.

At operation, the distal fourth of the shaft of the ulna was resected entirely, and the diseased soft tissue was excised. Postoperative treatment according to Orr's method was carried out. Specimens of bone and soft tissue removed at the operation proved to be tuberculous. There was no biopsy of the tibial lesion, but, on the basis of the presence of an active pulmonary tuberculosis and the positive microscopic diagnosis of tuberculosis of the ulna, the tibial changes also were considered to be of the same nature.

Three months later, the pulmonary and bony lesions showed no improvement. Further treatment was not accepted by the patient.

CASE 12. A Chinese boy, aged five years, gave a history of pain and swelling of two months' duration in the upper portion of the left arm. The swelling gradually increased in size until it ruptured, with a discharge of pus, two weeks before admission to the Hospital.

The general physical examination presented essentially normal findings except for the condition of the bone.

Roentgenograms showed a small circumscribed abscess in the central portion of the proximal third of the shaft of the left ulna, two centimeters distal to the joint surface of the coronoid process. The roentgenographic appearance was that of a bone abscess of the Brodie type.

This cavity was curetted and the bone was saucerized. Since a draining sinus was present, the wound was left wide open, packed with vaselin gauze, and treated according

FIG. 6

Roentgenogram of Case 6, showing the form of tuberculous lesion designated as Type III. The distal third of the radius is destroyed, with abscess formation and sequestration. The adjacent cortex shows condensation and thickening throughout approximately one-half of the shaft. In the thickened cortex there are many minute areas of erosion. Dense periosteal bone may be seen on the ulnar side of the lesion.

FIG. 7

Roentgenogram of the same case shown in Fig. 6, taken thirteen months later and eight months after operation, showing healing of the diseased area.

to Orr's method. Microscopic examination of the bone revealed the presence of tuberculosis. The wound of the bone and soft tissue healed in approximately three months.

The patient was seen eighteen months after the operation. At that time the lesion of the bone was healed and evidence of tuberculosis in other parts of the body was not found.

CASE 13. A Chinese girl, aged six years, was admitted to the Hospital because of a discharging sinus of one year's duration over the upper third of the left leg.

General physical and laboratory examinations showed essentially normal findings except for the surgical condition.

Roentgenograms showed an oval-shaped area of destruction of the proximal third of the shaft of the left tibia, two centimeters below the epiphyseal line. There was slight condensation of the bone surrounding the abscess.

The bone was saucerized and treated according to Orr's method. Microscopic examination of tissues removed at operation showed evidence of tuberculosis. The

wound failed to heal. Consequently, a second operation was performed one and one-half years later, at which time the bone again was saucerized and parts of the diseased soft tissue were resected.

Eight months after the second operation the wound healed and the lesion in the bone appeared quiescent. There was no extension of the infection into the epiphysis or into the knee joint. The general condition of the patient was excellent. The function of the knee was good.

CASE 14. A Chinese girl, aged nineteen years, first noticed a painful swelling of the right forearm nine months prior to admission. Three months after the onset, the swelling ruptured and discharged thin, yellow pus. A sinus was present at the time of admission. The general physical examination was essentially negative except for the condition of the bone.

Roentgenograms showed a well defined walled-off abscess of the bone in the distal third of the shaft of the right radius.

At operation, the old sinus tract was followed down to the bone; the bone was curetted, and a sequestrum and some caseous material were removed from the cavity. The cavity was swabbed with iodine and alcohol, and Orr's principles of postoperative treatment were followed. Microscopic examination of the bone and soft tissue removed from the diseased area showed evidence of tuberculosis. The patient received the usual conservative treatment.

In a follow-up letter, two years later, the patient stated that a discharging sinus was still present in the lower forearm. The patient's general health was excellent.

CASE 15. A Chinese male, aged twenty-two years, was admitted to the Hospital for the treatment of tuberculous cervical lymphadenitis and osteomyelitis of the left ulna.

The general physical and laboratory examinations showed essentially normal findings except for the conditions named.

Roentgenograms showed a large area of rarefaction of the central portion of the proximal third of the shaft of the left ulna, with condensation of the surrounding bone.

The operative treatment consisted of resection of the diseased soft tissue, saucerization of the bone, and immobilization according to the Orr method. Microscopic examination of specimens of bone and soft tissue showed evidence of tuberculosis.

Seven months after operation, the wound over the left ulna had healed completely, and the patient's general condition was excellent. The tuberculous infection of the cervical lymph glands remained quiescent.

CASE 16. A Chinese girl, aged eight years, complained of a chronic, painful swelling of six months' duration over the upper portion of the right leg. Three months prior to admission, the swelling ruptured, with a discharge of thin, yellow pus. The discharge continued until the time of admission. Two weeks prior to admission, the patient began to notice pain in the lumbar region.

Roentgenographic examination showed a central destructive lesion in the upper third of the shaft of the right tibia. In the proximal end of the shaft of the left tibia, there was an area of rarefaction which extended through the epiphyseal line and involved the epiphysis. Later examination showed destruction of the body of the fifth lumbar vertebra.

The lesion of the right tibia was explored. The bone in the area of the abscess was saucerized and the cavity was curetted. Specimens of bone and soft tissue taken from the diseased area proved to be tuberculous. The patient received conservative treatment at home.

Eight months later, in a follow-up letter, the parents stated that paralysis of the leg and bladder had developed. Hospital treatment was advised, but was refused.

CASE 17. A Chinese girl, aged fifteen years, gave a history of the insidious onset (nine months previous to admission) of pain and swelling in the upper portion of the

right forearm. About one month before admission, the swelling ruptured, with a discharge of pus.

Roentgenograms showed a circumscribed chronic bone abscess in the proximal end of the shaft of the right ulna.

The operative treatment consisted of saucerization and curettage of the bone. Specimens of bone and soft tissue removed at the operation showed microscopic evidence of tuberculosis. The usual conservative treatment was carried out.

In a follow-up letter, received ten months after operation, the patient stated that the wound continued to discharge a small amount of yellow, purulent material. At that time, the patient did not have any symptoms of pulmonary or visceral tuberculosis.

CASE 18. A Chinese male, aged twenty-one years, complained of a painful swelling with a discharging sinus of three months' duration over the left second metacarpal region, and a painful swelling with a discharging sinus of one month's duration over the lower third of the right fibula.

General physical and roentgenographic examinations revealed essentially normal findings except for the condition of the bones. There was rarefaction and destruction of the entire thickness of the cortex of the left second metacarpal bone (spina ventosa), and also of the distal third of the shaft of the right fibula. There was no evidence of extension of the lesion into the ankle joint. In the fibula there was marked lace-like formation of new bone in the periosteum of the involved area.

Evidence of tuberculosis was found in the granulation tissue which was curetted from the draining sinuses. Surgical treatment of the tuberculous osteomyelitis was advised, but was refused by the patient.

CASE 19. A Chinese girl, aged sixteen years, stated that, eight months previous to admission to the Hospital, a painful swelling had developed gradually in the lower portion of the right forearm. Four months after the onset, the swelling ruptured, with a discharge of thin, yellow pus. Seven months prior to admission, the patient noticed slight pain and swelling of the left knee joint.

Physical and roentgenographic examinations showed a localized area of destruction of bone in the distal third of the shaft of the right radius. The wrist joint was not involved.

An operation was performed on the right radius, during which the bone was saucerized and the diseased soft tissue was resected. Because of extensive secondary infection, Orr's treatment was used.

Approximately one year after the operation, the infection of the bone and soft tissue of the right radius appeared quiescent.

Because of persistence of pain and swelling in the left knee, an exploratory operation was performed on that joint. Microscopic examination of the synovial tissues of the knee showed tuberculosis. Consequently, an arthrodesis was performed. Four months after the operation, the bones of the knee joint had fused solidly. The patient received the usual conservative treatment.

Seven months after the second operation, the patient's general condition was good. Both tuberculous lesions (radius and knee) appeared quiescent.

CASE 20. A Chinese male, aged twenty-one years, was admitted to the Hospital because of chronic swellings and draining sinuses over the lower portion of the left leg, right fifth metacarpal bone, and right elbow joint.

General physical and roentgenographic examinations showed normal findings except for the lesions in the bones. Specimens of granulation tissue curetted from the sinuses showed microscopic evidence of tuberculosis. Roentgenograms demonstrated extensive tuberculous lesions in the regions of the right elbow, the right fifth metacarpal bone, and the lower third of the shaft of the left tibia. There were several draining sinuses just above the left internal malleolus. There was definite tuberculous involvement of the synovia of the ankle joint.

The right arm was amputated several days after admission. Four weeks later, the lesion in the shaft of the tibia was saucerized and, in addition, an arthrodesis was performed on the ankle joint.

TABLE I

TABULATION OF CASES

Case	Age and Sex	Location of Lesion	Type of Lesion *	Tuberculosis Proved (Microscope)	Associated Tuberculosis	Operative Treatment	Results
1	37 F	Tibia, middle third.	I	Yes	None	Bone saucerized.	Good. Six months after operation, lesion of bone appeared quiescent. No sinus.
2	21 M	Radius, distal third.	III	Yes	None	Bone saucerized. Partial ostectomy.	Good. Wound healed one year after operation. Function of right hand good. No sinus.
3	7 F	Femur, lower third.	III	Yes	None	Bone saucerized.	Good. Lesion quiescent after one year. No drainage.
4	40 M	Humerus, upper third.	III	Yes	Extension into shoulder joint and axilla.	Resection of upper end of humerus; Orr's treatment.	Poor. Unimproved. Incomplete follow-up. Sinuses present.
5	33 F	Tibia, upper third.	III	Yes	Pulmonary tuberculosis, moderately advanced.	Bone saucerized.	Fair. Bone lesion quiescent six months after operation. No drainage.
6	19 M	Radius, distal third.	III	Yes	Suppurative tuberculosis of axillary glands.	Bone saucerized; Orr's treatment.	Poor. Bone lesion unhealed two years after operation. Abscess present.
7	11 F	Tibia, middle and distal thirds.	III	Yes	Pulmonary tuberculosis, minimal, active.	Bone saucerized.	Poor. Pulmonary condition improved. Bone lesion active. Two years later, discharging sinus still present over bone lesion.
8	19 F	Tibia, upper third.	III	Yes	Pulmonary tuberculosis, moderately advanced.	Bone saucerized.	Poor. Pulmonary tuberculosis and bone lesion growing progressively worse one year later.
9	32 M	Tibia, upper third.	III	Yes	Pulmonary tuberculosis, moderately advanced.	Bone saucerized.	Fair. Bone lesion relatively quiescent one year after operation. Sinus present.
10	5 M	Tibia, lower third.	II	Yes	None	Two saucerization operations.	Good. Lesion quiescent four months after operation. Examination two years later showed healed lesion.

11	27 F	Tibia, middle third. Ulna, distal fourth.	I II	Yes	Pulmonary tuberculosis, moderately advanced.	Resection of distal end of ulna.	Fair. Pulmonary condition stationary. Diseased area of bone excised. Three months after operation, wound healed and pulmonary condition improved. No further follow-up.
12	5 M	Ulna, proximal third.	II	Yes	None	Bone saucerized.	Good. Wound healed three months later. Apparent cure at follow-up one and one-half years later.
13	6 F	Tibia, upper third.	II	Yes	None	Two ostectomies.	Good. Eight months later, after second operation, wound healed. Bone lesion quiescent. No discharge.
14	19 F	Radius, lower third.	II	Yes	None	Bone saucerized.	Good. Lesion active, with a draining sinus still present two years after operation.
15	22 M	Ulna, upper half.	II	Yes	None	Bone saucerized; Orr's treatment.	Good. Lesion quiescent after seven months. Function of elbow good.
16	8 F	Tibia, right, upper third.	II	Yes	Fifth lumbar vertebra; left tibia.	Partial ostectomy of right tibia.	Poor. Both bone lesions very active eight months later.
17	15 F	Ulna, upper third.	II	Yes	None	Resection of ulna.	Fair. Ten months after operation, bone lesion relatively quiescent. Small sinus present.
18	21 M	Fibula, lower third.	III	Yes	Metacarpal region.	Refused treatment.	
19	16 F	Radius, distal third.	II	Yes	Knee joint.	Bone saucerized. Arthrodesis of knee.	Good. Lesion of radius quiescent after seven months. No sinus. Solid union of knee after four months.
20	21 M	Tibia, lower third.	II	Yes	Ulna (elbow joint); metacarpal bone.	Partial ostectomy of tibia. Amputation of arm.	Fair. At follow-up three months later, lesion becoming quiescent.

* Type of Lesion:
I—Tuberculous Periostitis
II—Solitary Tuberculous Abscess (Brodie's Type)
III—Localized Tuberculous Osteomyelitis
IV—Massive Tuberculous Osteomyelitis (See Figs. 10 and 11)

Three months after the second operation, the patient's general condition was very satisfactory. There was beginning fusion of the ankle joint. The wound over the shaft of the tibia continued to show a small amount of discharge. The patient is still in the Hospital.

FIG. 8

Roentgenogram of Case 2 (Type III). An oval-shaped area of destruction, with a sequestrum, is seen in the distal end of the diaphysis of the radius. The cortex is thickened, laminated, rarefied, and eroded irregularly. The periosteum shows irregular proliferation. The serrated edges of the periosteal bone are often seen in cases with mixed pyogenic infection.

CLINICAL AND ROENTGENOGRAPHIC FINDINGS

In the group of cases under consideration, the symptoms differed in severity according to the virulence of the infection and the extent of the lesion in the bone. In the cases which showed the most extensive lesions (massive tuberculous infiltration of the entire shaft), the onset was subacute and was characterized by severe pain and swelling of the involved section of the limb. The pain and tenderness was marked during the first two weeks, after which time fluctuant swellings were noted in the soft tissues. The temperature of the patients varied from 37.2 degrees centigrade to 38.5 degrees. This form of tuberculous osteomyelitis * might easily have been mistaken for acute pyogenic infection of the bone.

Most of the cases, however, were of the less virulent form, and the infection was limited to a smaller portion of the shaft. In these cases, the infection was characterized by an insidious onset and a chronic course. Pain of a dull, aching character and muscle spasm were present for several days or weeks, following which soft-tissue swellings developed gradually. During this time, most of the patients showed a slight febrile reaction, accompanied by general malaise and a slight loss of weight. Usually the abscesses were not of the "cold" type, such as the gravitation abscesses of tuberculosis of the spine. In the cases of shaft tuberculosis, the abscesses formed directly

* Cases with a similar type of onset have been described by Reichel, Von Friedländer, Zumsteeg, Gralka, and others. In Gralka's cases, the onset of pain and disability was acute; the patient showed a temperature of 37.6 degrees centigrade and examination of the blood showed a white-cell count of 17,000.

over the diseased areas of the bone, and, since there was a great increase of the local blood supply, the skin over the abscesses was often hot and red, and the areas were tender on palpation. After several weeks, the abscesses tended to rupture spontaneously. This form of tuberculous infection of the shaft of the long bones differed from pyogenic osteomyelitis in that, as a rule, the onset was less acute, the pain was less severe, the febrile reaction was less pronounced, and the leukocyte count of the blood did not show a great increase in the number of polymorphonuclear cells.

FIG. 9

Roentgenogram of Case 7 (Type III). The middle and distal thirds of the tibia present a large, poorly defined area of destruction. The cortex is thickened markedly, condensed irregularly, and rarefied (striated) with minute areas of erosion. The periosteal new bone is similarly involved.

In cases showing a circumscribed tuberculous abscess, the symptoms were similar to those of the Brodie's abscess of pyogenic osteomyelitis. As a rule, the onset was insidious and there were no constitutional symptoms. The patients complained of occasional attacks of dull, aching pain in the region of the lesion. Usually, pain was the only complaint during the first two or three months. Later on, however, the tuberculous abscesses showed a tendency to extend slowly through the cortex of the bone, eventually forming sinus tracts leading to the surface.

In those cases showing tuberculous involvement of the periosteum, there were symptoms of mild, chronic pain and tenderness over the area of the lesion. There were no constitutional symptoms which could be ascribed to the local lesion.

Since the pathological and the clinical pictures of shaft tuberculosis are often similar to those found in pyogenic osteomyelitis, it is to be expected that errors will be made in the differentiation of these conditions.

FIG. 10

Roentgenogram showing the form of tuberculous lesion designated as Type IV. Note the massive involvement of the entire shaft of the ulna. Two large abscesses are present, one in the proximal portion and the other at the junction of the middle and distal thirds. The cortex is markedly thickened, rarefied, and striated. The elbow and wrist joints are not involved. (Dr. G. W. VanGorder's case.)

FIG. 11

Roentgenogram showing another instance of a lesion classified as Type IV. There are large abscesses, with sequestra, in the middle and distal thirds of the shaft of the radius. The cortex of the entire diaphysis shows rarefied thickening with multiple small areas of destruction. (Dr. G. W. VanGorder's case.)

However, in our study, we found certain changes in the roentgenograms which suggested the diagnosis of tuberculosis. When the periosteum was involved, the newly formed bone appeared to be rarefied irregularly and striated longitudinally. When the cortex was involved, it showed a thickening which was usually of the rarefying type, with a laminated appearance. In this rarefied, thickened cortex, or periosteal new bone, there were single or multiple areas of erosion or destruction. These destructive lesions were often very small and, therefore, careful examination was required for their detection. It should be emphasized that destruction of bone was considered the most important diagnostic finding even in those cases where proliferation predominated. In rare instances, the thickened cortex, or periosteal new bone, was condensed and sclerosed, with no areas of rarefaction or erosion. In such cases, the diagnosis of sclerosing osteomyelitis or syphilis was usually made. In the entire series of cases of tuberculosis of the shaft of long bones, a correct roentgenographic diagnosis was made in eleven instances. In four other instances, tuberculosis of the shaft was diagnosed largely on the strength of the characteristic, active, tuberculous lesions in the lungs and other bones. Taken together, a correct diagnosis was made in fifteen out of the twenty cases. A diagnosis of syphilis of bone was made in two cases and of chronic osteomyelitis in three cases. We attribute the comparatively high percentage of correct diagnoses largely to the fact that tuberculosis is very prevalent in North China, and, therefore, is always considered even in unusual locations.

We have divided the lesions into four types according to the roentgenographic appearance. This division is based largely on the location and extent of the lesions (see Table I).

Type I—Tuberculous Periostitis: This is the rarest form of shaft tuberculosis. It is characterized by rarefied, laminated, new bone in the periosteum over an apparently intact cortex (Figs. 1 and 2).

Type II—Solitary Tuberculous Abscess (Brodie's Type): This form is represented by a single area of destruction, usually located centrally in or near the metaphysis. The abscess may or may not be well circumscribed. In the early stages, there is relatively little condensation around its periphery, but, in the later stages, it is usually surrounded by fairly dense bone. Sometimes sequestra are present. Late in the course of the disease, the destructive process may involve the surrounding portion of the bone by direct extension, and then it becomes impossible to distinguish this type (Figs. 3, 4, and 5) from Type III.

Type III—Localized Tuberculous Osteomyelitis: In this form, a larger portion of the shaft is involved. Early in the disease, the medullary and cortical portions of the bone appear hazy and decalcified, with scattered rarefied areas of destruction. After many months, the destroyed areas of the medullary region show sharper lines of demarcation, and the cortex shows irregular areas of destruction and condensation. When the superficial layers of the cortex and the periosteum are involved, there

is usually a certain amount of involucrum present, which, although less in amount and less dense and homogeneous, may be very similar to that found in pyogenic osteomyelitis. Later in the disease, after sinuses have developed externally, the roentgenographic findings are frequently very confusing, because of the added factor of secondary infection which usually stimulates the formation of involucrum. In cases with mixed infection, the periosteal new bone often presents a very irregular outer surface, with fringy, serrated, or radiating projections of involucrum (Figs. 6, 7, 8, and 9).

Type IV—Massive Tuberculous Osteomyelitis: During the early stages of this lesion, roentgenograms show marked decalcification of the shaft, usually with a fusiform swelling of the periosteum and surrounding soft tissues. As a rule, in this type the circulation of the periosteum is not seriously affected, and, therefore, laminated layers of involucrum may be seen after several weeks or months. At this time, the cortical and medullary bone of the shaft shows extensive decalcification, with many scattered areas of destruction (Figs. 10 and 11).

COMMENT

In spite of the possibilities of making a correct diagnosis of shaft tuberculosis by clinical and roentgenographic signs, we have encouraged the use of an exploratory operation and microscopic diagnosis in every case, so that from the start we might be guided correctly in the treatment of the local condition. Also, because of the unreliability of physical findings in early pulmonary tuberculosis, we have secured roentgenograms of the lungs in every case of tuberculosis of the bone. With this help, we have been able to prescribe at an earlier date correct management of the patient's general condition.

The patients with shaft tuberculosis and active pulmonary lesions did not usually respond favorably to treatment. In these cases, the treatment of the pulmonary condition was considered of primary importance, and the lesions of the bone were treated by the usual measures. It is believed that amputation of an extremity may be strongly indicated in these cases, especially since complete eradication of an active peripheral focus may allow a greater chance for control of the visceral lesions.

Approximately seventy-five per cent. of the uncomplicated cases of shaft tuberculosis (those without associated tuberculous lesions) responded favorably, following the usual orthopaedic care. The operative treatment of the closed lesions (those without sinuses) consisted of unroofing of the diseased area of the bone and, whenever feasible, excision of as much as possible of the diseased bone and soft tissue. The defect in the bone was left unfilled, the wound was closed, and a plaster-of-Paris cast was applied.

The open cases (those with draining sinuses and accompanying secondary infection) were treated in much the same manner as the ordinary case of pyogenic osteomyelitis. However, in addition to the usual pro-

cedure, as much of the infected bone was excised as was possible without causing an interruption of its continuity. Wide excision of the tuberculous soft tissue was also carried out. Following the unroofing and excision procedure, the wound was packed with vaselin gauze and a cast applied according to the technique of Orr. In our hands, the Orr method has proved very satisfactory.

In many of our cases, secondary infection seemed to have a favorable influence upon the healing of tuberculous lesions of the shaft. We believe these observations to be correct, and explain them on the basis of an increased fibroblastic reaction of the soft tissues, as a result of which the tubercles become walled off and quiescent.

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EXPERIMENTAL MUSCULAR ATROPHY*

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Because of the great variation in the extent of muscular atrophy resulting from simple immobilization as found by different workers[1,2], a series of experiments upon normal rabbits was undertaken to determine whether or not the extent of this atrophy could be limited by allowing weight-bearing.

One hind limb was immobilized for a period varying from one to six weeks, and the amount of atrophy determined by comparing the weights of the muscles of that limb with the weights of the corresponding ones of the opposite side. To determine what constituted a significant variation, the weights of the corresponding muscle groups from the two sides of untreated animals were compared.

EXPERIMENTAL METHODS

Controls

In a series consisting of ten normal rabbits and two rabbits with miliary tuberculosis, several groups of muscles were dissected out and compared with the same muscle groups in the opposite leg.

A standard method of removing and separating the different muscle groups, similar to that described by Beryl Harding [1], was used. The gastrocnemius and soleus, from their origins to their common insertion into the os calcis, were dissected out as one group. The quadriceps femoris, gluteus medius, and gluteus minimus formed a second group. The gluteus maximus, the hamstring muscles, and the adductors of the thigh were dissected out as a third group, leaving the other muscles of the hip intact. These three groups will be called: (1) Calf, (2) Thigh, (3) Ham.

Immediately after the animals were killed, the muscle groups were dissected out exactly and weighed at once. It was not considered necessary or desirable to desiccate the muscles before weighing them, as advocated by Lippmann and Selig [2].

EFFECT OF IMMOBILIZATION

Group 1. Weight-Bearing Allowed

Plaster-of-Paris spica casts were applied to a group of rabbits with the right hind limb flexed in a natural position, thus allowing weight-bearing but preventing motion (Fig. 1).

* From the Sir William Dunn School of Pathology, Oxford.

Group 2. Non-Weight-Bearing

Another group of rabbits were put into plaster-of-Paris spicas with the right hind limb fully extended, so that weight-bearing was impossible (Fig. 2).

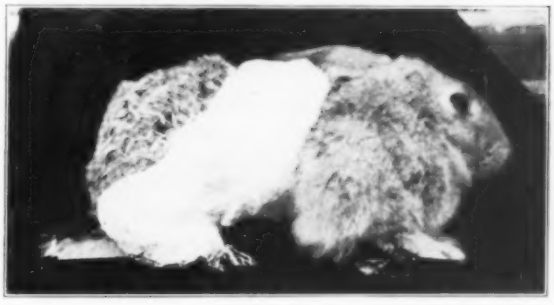

FIG. 1

Flexed or weight-bearing position.

One rabbit from each group was killed at the end of each week for six consecutive weeks; the muscles were dissected out and their weights compared as in the control group. Microscopic sections of the muscles were made, and the bones were weighed and roentgenographed.

GENERAL OBSERVATIONS

In applying plaster to rabbits some difficulty was encountered. Plaster could be applied without padding of any kind and the circulation of the foot would remain good for several days. However, after three to seven days, the foot would become swollen and this oedema would only slowly subside after the plaster had been bivalved. For this reason cotton-

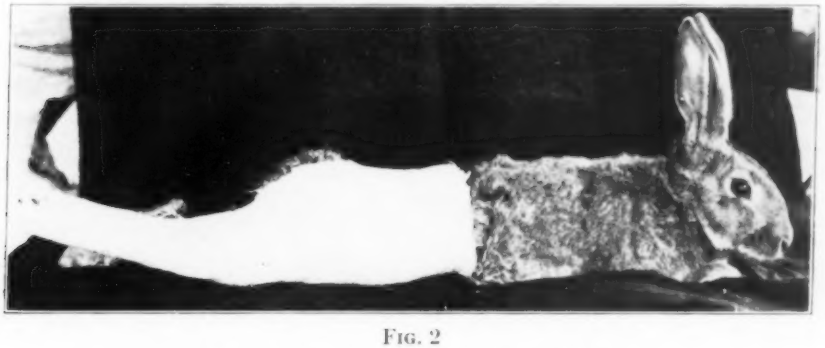

FIG. 2

Extended or non-weight-bearing position.

wool padding was applied, especially around the knee, and any animal showing oedema of the foot at any time was discarded. No matter how great care was used in applying the plaster, and although there were absolutely no circulatory changes in the foot nor abrasions on the leg, there was always slight oedema to be seen in the muscles about the knee, if they were removed within a few hours after the removal of the plaster from the animal. Because of this, each rabbit was allowed forty-eight hours of freedom from plaster before it was killed and the muscles were removed.

All animals were quite active in plaster and remained in good condition except for a slight loss in weight. After the plaster was removed,

they gradually began to use the leg which had been immobilized. Those in which the leg had been in the weight-bearing position seemed almost normal within a few hours, while those which had had the leg in the extended position did not recover full use of it during the forty-eight hours that they were allowed free.

RESULTS

Gross Anatomy

The muscles of the immobilized leg showed definite changes, depending upon the length of time that the animal had been in plaster. There was often slight oedema of the tissues about the tendo achillis. After the first week or two the muscles were found to be flabby, moist, and pale. The red muscles had lost their color and become indistinguishable from the white ones. After six weeks' immobilization the changes were very striking, especially in those animals in which weight-bearing had not been allowed. The skin and subcutaneous tissue were not so freely movable as in the normal leg. The muscles were not compact groups of firm fibers, but were soft masses of pale oedematous material with considerable areolar and fibrous tissue scattered through them. They were inelastic and not easily divided into groups.

The bones showed no gross differences and no definite changes in the roentgenograms. The bones of the immobilized leg usually weighed less than those of the other leg, but the difference was not enough to be significant.

Loss of Weight

The variation in weight in the different muscle groups of the control animals is shown in Table I. The differences between the muscles of the two legs in normal animals are very small. The average variation is 1.9

TABLE I

WEIGHTS OF NORMAL RABBIT MUSCLES

Animal No.	Weight in Grams	Calf		Thigh		Ham		Total	
		Right	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*
A	1830	13.1	12.9	43.1	43.3	63.5	62.5	119.8	118.7
992	1900	11.8	11.8	41.4	38.6	66.0	67.8	119.2	118.2
991	1361	8.3	8.4	27.2	28.2	38.2	36.7	73.7	73.3
1052	2023	15.5	15.5	44.0	42.6	69.8	67.0	129.3	125.1
1056	2345	17.0	17.5	62.5	62.5	79.0	79.2	158.5	159.2
1057	2165	16.3	16.0	47.0	46.0	66.1	67.9	129.4	129.9
1058	2230	16.5	16.5	47.4	48.6	66.5	66.5	130.4	131.6
1059	1975	14.2	14.1	44.1	43.7	64.5	65.7	122.8	123.5
a	2985	18.1	17.6	66.8	64.6	95.6	94.4	180.5	176.6
b	2660	17.6	16.8	64.5	64.4	98.9	96.4	181.0	177.6
c	2743	17.5	17.2	62.2	62.1	94.6	97.4	174.3	176.7
d	2330	14.0	14.2	53.2	53.4	78.2	78.1	145.4	145.7

TABLE II

WEIGHTS OF MUSCLE GROUPS
WEIGHT-BEARING POSITION

Animal No.	Time in Plaster	Weight in Grams	Loss of Weight	Calf		Thigh		Ham		Total	
				Right	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*
1106	1 week	2776	61*	17.4	16.6	65.8	69.0	85.0	86.0	168.2	171.6
1133	2 weeks	2630	150	14.9	16.6	52.0	55.3	77.9	79.2	144.8	151.1
1105	3 weeks	2725	275	15.9	17.6	61.0	64.0	90.0	93.3	166.9	174.9
1103	4 weeks	3230	200	24.4	24.8	82.1	82.5	107.9	119.9	214.4	227.2
1134	5 weeks	2100	35	11.6	14.2	49.2	48.8	66.5	63.8	127.3	126.8
1104	6 weeks	2553	73	12.5	18.0	53.8	56.6	65.4	72.8	131.7	147.4

* Gain.

per cent. of the muscle weight, and the only marked discrepancy is seen in Rabbit 992 in which the thigh muscles of the left leg weighed 2.8 grams less than those of the right. This rabbit had miliary tuberculosis and was generally underweight.

The atrophy in the three muscle groups in the immobilized animals is shown in Tables II and III. It is roughly proportional to the time of immobilization and definitely greater in those animals in the non-weight-bearing position. A few results seem inconsistent, but they are generally quite uniform. Rabbit 1134, after five weeks in the flexed position, showed atrophy in the calf and slight increase in weight in the other groups. This animal was allowed three days out of plaster before being killed and was unusually active. In this position the immobilization is best in the calf muscles and in them the atrophy is most marked. Rabbit 1101, after four weeks in the extended position, showed no atrophy in the thigh muscles. This was probably due to the fact that he was killed twenty-four hours after the plaster was removed and there was still slight oedema above the knee.

The total atrophy of the three muscle groups is shown in Figure 3. The

TABLE III

WEIGHTS OF MUSCLE GROUPS
NON-WEIGHT-BEARING POSITION

Animal No.	Time in Plaster	Weight in Grams	Loss of Weight	Calf		Thigh		Ham		Total	
				Right	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*
1132	1 week	2515	338	15.3	19.0	55.0	56.7	81.6	85.0	151.9	160.7
1138	2 weeks	2590	110	13.4	16.8	47.5	57.4	73.2	77.5	134.1	151.7
1100	3 weeks	2205	95	11.0	14.4	40.5	51.2	58.0	66.1	109.5	131.7
1101	4 weeks	2424	376	10.0	15.2	46.8	46.8	56.0	72.3	112.8	134.3
1125	5 weeks	1715	158	5.9	10.3	27.0	36.9	37.9	47.6	70.8	94.8
1099	6 weeks	2056	475	9.1	16.3	42.8	54.5	54.6	72.5	106.5	143.3

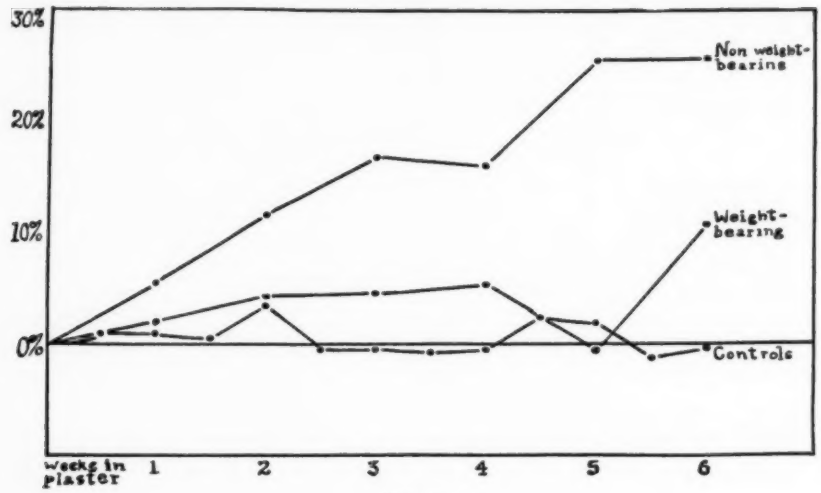

FIG. 3

Total atrophy in three groups of muscles.

loss in weight is shown in percentages of the weight of the normal muscles. The atrophy of the calf muscles is shown in Figure 4. In this group of muscles, which were most completely immobilized, the atrophy was very

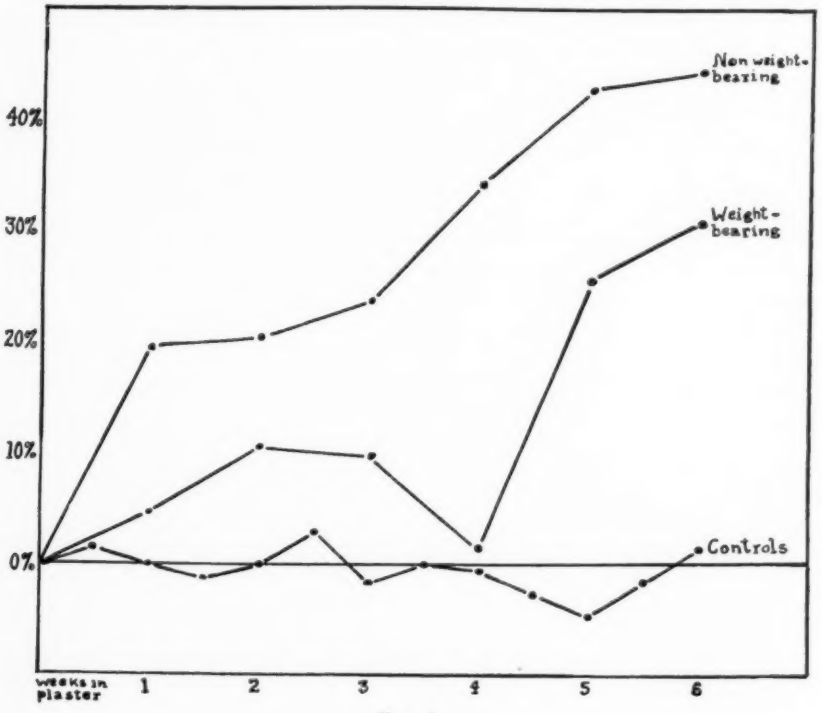

FIG. 4

Atrophy of calf muscles.

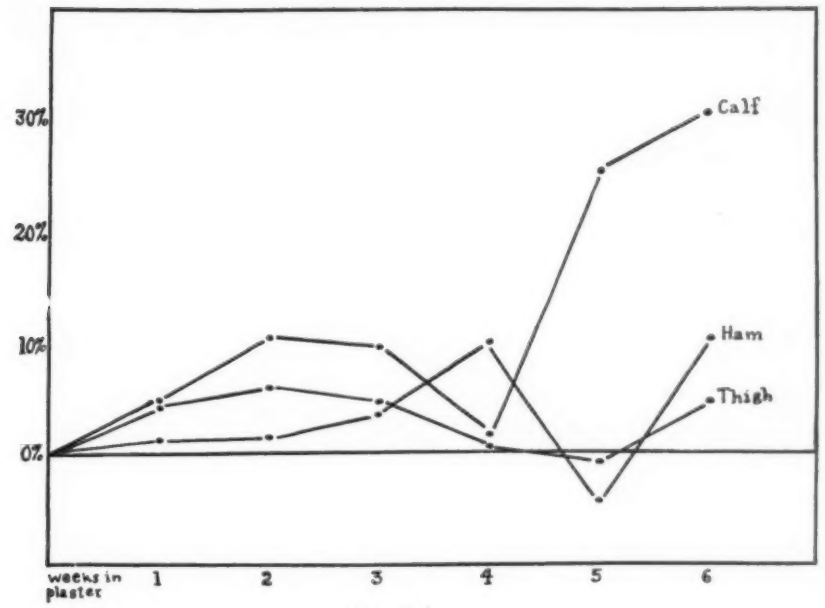

FIG. 5-A

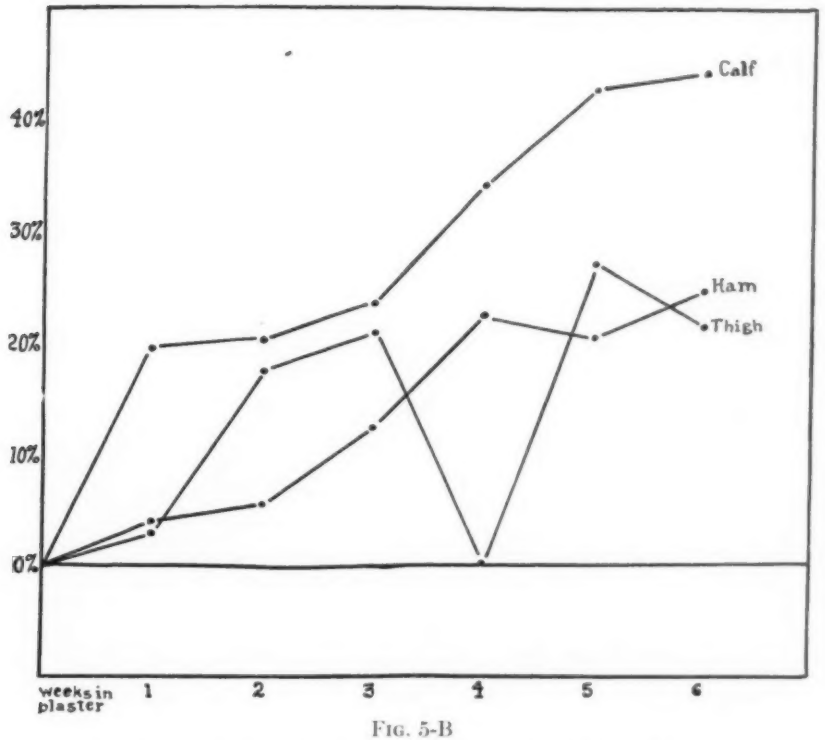

FIG. 5-B

Comparison of atrophy of calf, ham, and thigh muscles.
FIG. 5-A. Weight-bearing. FIG. 5-B. Non-weight-bearing.

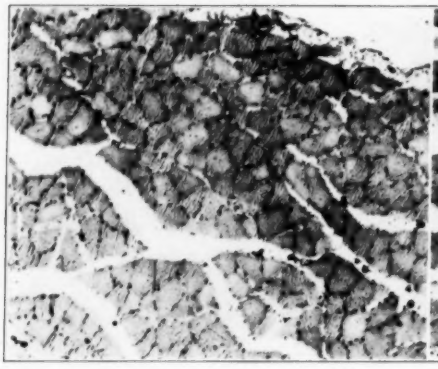

FIG. 6

(1125L) Cross section of normal rabbit muscle, showing mixed red and white fibers.

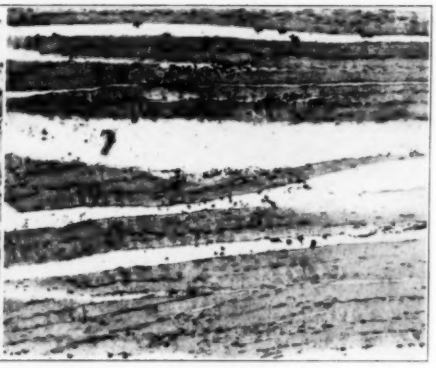

FIG. 9

(1131L) Longitudinal section of normal rabbit muscle.

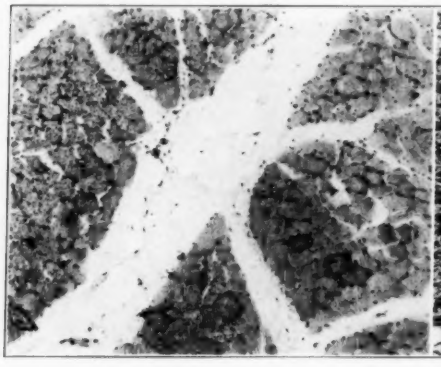

FIG. 7

(1125R) Cross section of muscle after five weeks' immobilization. The fibers stain equally and are pale. The average size of the fibers is less.

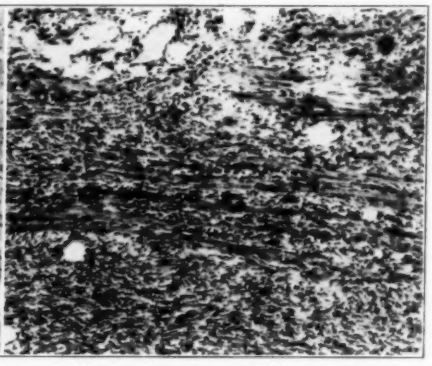

FIG. 10

(1125R) Longitudinal section of rabbit muscle after five weeks' immobilization, showing extensive fibrosis with faintly stained, poorly outlined muscle fibers.

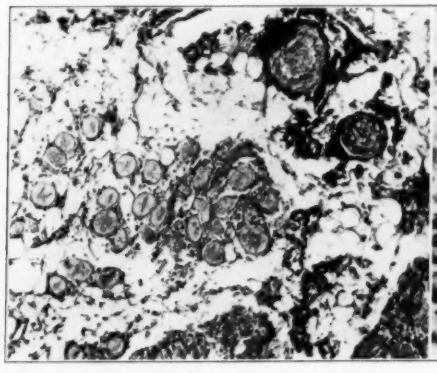

FIG. 8

(1099R) Cross section of part of a muscle after six weeks' immobilization, showing muscle fibers scattered through areolar tissue.

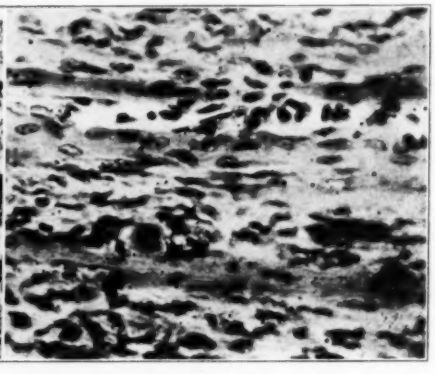

FIG. 11

(1125R) High-power photomicrograph of same muscle.

extensive, amounting to forty-four per cent. of the normal weight in one instance.

In Figures 5-A and 5-B the atrophy in the three different muscle groups is compared. These charts show the atrophy to be considerably greater in the calf muscles than in the other two groups in both the weight-bearing and non-weight-bearing animals.

Microscopic Changes

No attempt was made to make a detailed study of the histological changes as atrophy progressed, but the gross changes were so striking that a few sections were made, some of which are reproduced in Figures 6–11. The greater number of sections showed pale, evenly stained fibers, and of slightly smaller average size in animals which had been immobilized five or six weeks than those in the normal muscle. There were scattered areas of comparatively normal muscle, while a few muscle fibers were found scattered through loose areolar tissue and not grouped together into bundles. A few areas showed marked fibrosis through which were scattered a few pale, poorly outlined, apparently degenerating muscle fibers.

DISCUSSION

The atrophy of disuse is rapid and extensive; but it can be limited greatly by allowing weight-bearing. This fact can be of practical value in the regulation of treatment leading to the reduction of the period of immobilization, and allowing normal function in the form of weight-bearing at the earliest possible moment. Further studies are desirable, in order to determine whether or not a muscle, which has lost thirty to forty per cent. of its weight and shows definite histological changes, can completely regain its previous weight and normal structure.

CONCLUSIONS

1. Extensive muscular atrophy can be produced in rabbits by immobilization in plaster.
2. The extent of this atrophy can be considerably lessened by permitting weight-bearing.
3. Under the conditions of these experiments the calf muscles showed more atrophy than the thigh or hamstring muscles.

The author wishes to thank Prof. Dreyer for the privilege of working at the Sir William Dunn Pathology Laboratory and the staff for their cooperation and assistance.

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MAGGOT THERAPY

Technique and Clinical Application *

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NEW ORLEANS, LOUISIANA

Since the publication of Baer's reports [1, 2, 3] on the therapeutic use of fly larvae in various surgical conditions, many articles [4, 5, 6, 7, 8] have appeared, in all of which this type of therapy is recommended as a valuable adjunct to the surgeon's armamentarium. It is admitted that the difficulties encountered limit its use to large institutions in which the services of an entomologist are available. Briefly, these difficulties are as follows: (1) the securing of a suitable variety of fly; (2) the constant production of large quantities of eggs; (3) the sterilization of eggs; and (4) a satisfactory means of confining the maggots in the wound. During the past six months, we have conducted experiments designed to overcome these difficulties. Our results have been so uniformly successful, and the cost of production so low, that we feel justified in reporting our experience.

SOURCE OF LAYING STOCK

Our original laying stock was obtained by exposing fresh meat in the open near a meat market. The meat, with the accompanying eggs, was placed in a pint jar and the top covered tightly with a piece of sheeting. Unfortunately, liquefaction of the meat resulted in the drowning of the maggots. Further experimentation led us to discover that, if support was offered the maggots in the form of cotton or gauze half filling the jar, they were able to continue their growth. We learned later that Nettrour had made a similar observation [9]. The maggots, thus aided, grew to maturity and pupated in the gauze, the entire period occupying seven days.

The pupae were shaken out and tied in little gauze bags for convenience in handling. They were placed in a covered jar and allowed to hatch, the period required for hatching occupying from five to seven days.

Many varieties of flies hatched out. They included specimens of the blue-black blow fly (*Formia regina*), the gray flesh fly (*Sarcophaga hemorrhoidalis*), the bright green blow fly (*Lucilia sericata*), the Texas screw-worm fly (*Chrysomyia macellaria*), and a dull, copper-colored, greenish-tinged blow fly (*Lucilia cuprina*)†.

The flies were separated according to species by the following method, and placed in separate cages. After they had hatched in the jars, they were sprayed with ether through the sheeting by means of an atomizer, and the top of the jar was more securely covered with a Petri dish. After

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† Our identification of this species was confirmed by Aldrich of the National Museum, Washington.

a few minutes, the unconscious flies were emptied into a Petri dish and examined. With a little practice, it is possible to identify a large number of species in a short time. After examination, the flies were placed in the laying cages to revive. Those which were too immature to have identifying markings were replaced in the jar. Apparently, the ether had no ill effects, as very few flies failed to revive, and there was no impairment of laying ability. We still use this method of examination of flies in order to prevent contamination of our laying stock.

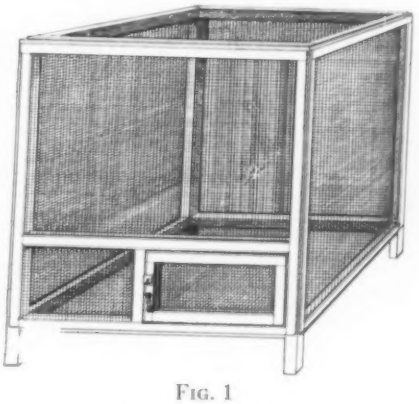

FIG. 1
Drawing of improved fly cage.

In order to compare the laying ability of the flies, approximately the same number were placed in each cage. The cages used were similar to those described by Murdoch and Smart [10]. We found that the *Lucilia cuprina*, which is mentioned by Fabre in his classic essay, "The Green Bottles", was the most prolific, and this is the fly which we use in our work (Fig. 2, *B*). Many writers report that their flies begin to lay within five to six days after hatching. *Lucilia cuprina* begins to lay within ninety-six hours after hatching. Whether this is characteristic of the species, or whether our climate is responsible, we do not know, but probably the former explanation is correct, as most workers use *Lucilia sericata*.

RECOGNITION OF THE TEXAS SCREW-WORM FLY

The ability to recognize the Texas screw-worm fly, which is found throughout the United States and southern Canada during the summer months, is of so much importance that the species warrants a detailed description. It resembles the *Lucilia sericata*, or green bottle fly, which is the variety most commonly used in maggot therapy. Morgan [11], in his detailed study of the Texas screw-worm fly, describes it as follows: "When the fly emerges, it is grey, but soon assumes its permanent color which is a bright, metallic green. Just behind the head (thorax) there are three distinct black stripes running from the head to the abdomen. The eyes are of a dull red color, and quite prominent. The wings are long, and in many instances lap one over the other on the body, presenting a narrowed appearance. The whole fly is a little larger than the ordinary house fly (*Musca domestica*)."

The larvae of the Texas screw-worm fly attack living tissue, boring their way through, and causing excruciating pain. Cattle die from infestation with larvae of this fly, and several cases of death in man have been reported. That this fly has contaminated fly broods is suggested by the experience of Buchman and Blair [12] who reported that one batch of their

maggots bored large cavities in healthy granulation tissue, actually increasing the size of the wound and causing considerable pain. Unfortunately, the entomologist to whom these flies were submitted was not able to identify the species (Fig. 2, *A*).

REARING OF FLIES

We have abandoned the use of the small cages in favor of a new cage, thirty by thirty by thirty inches, covered with copper screening, and capable of housing about 2,000 flies (Fig. 1).

The food consists of pieces of orange, sugar cubes, and lean meat. Recently a mixture of equal quantities of whole egg and orange juice has been added. This is poured on gauze placed in a Petri dish. The eggs are collected every four hours, at which time a fresh supply of meat is placed in the cage. We have found that a continuously fresh supply of meat increases the fecundity of the flies.

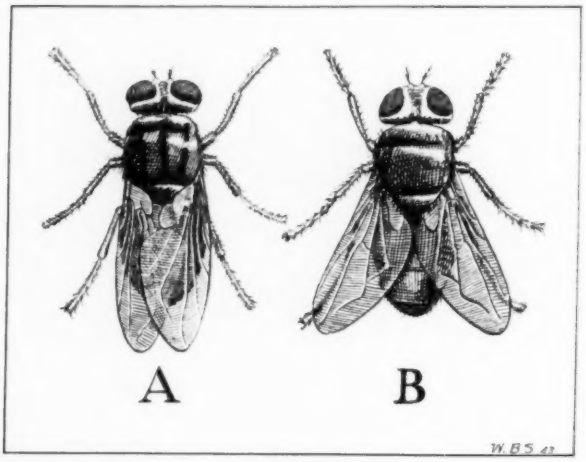

FIG. 2

A. Drawing of Texas screw-worm fly (*Chrysomyia macellaria*).
B. Drawing of *Lucilia cuprina*.

During the winter, the flies are kept in a steam-heated room, the temperature of which is maintained at about seventy degrees Fahrenheit. No attention is paid to the question of humidity or ventilation. The flies thrive, and their laying ability is not affected.

STERILIZATION OF EGGS

The eggs are collected every four hours. They are picked off the meat with a toothpick, placed on damp filter paper, and stored in the icebox. The sterilization process is as follows:

Separation of the Eggs: Various methods are in use; some workers shake the clumps of eggs vigorously in a test tube of saline solution; others wash them in Dakin's solution containing one per cent. sodium carbonate. We have obtained satisfactory results by rolling the clumps of eggs against the side of a test tube half filled with a 0.85 per cent. solution of sodium chloride, using a cotton-tipped applicator. The eggs, thus separated, sink to the bottom of the tube. The importance of the complete separation of eggs cannot be overemphasized. We attribute most of our failures in sterilization to incomplete separation of eggs.

Sterilization Apparatus (Fig. 3): The component parts are as follows:

1. A gallon jug, *A*, containing a ten per cent. solution of formalin, as first used by Child and Roberts [13], and later by Weil, Nettrour, and Sweadner [14]; a two-holed rubber stopper into which is inserted a glass funnel, filled with sterile absorbent cotton and covered with gauze, and rubber and glass tubing, connected with the sterilizing chamber, *C*.

2. A gallon jug, *B*, containing 0.85 per cent. sodium chloride solution, connected with the sterilizing chamber, *C*.

3. Sterilizing chamber *C*, consisting of: (*1*) a piece of glass tubing six inches by seven-eighths of an inch (a large culture tube with its lower end cut away may be used); (*2*) three rubber stoppers; (*3*) a funnel filled with absorbent cotton and covered with gauze; (*4*) miscellaneous pieces of glass and one-eighth inch rubber tubing. The chamber is closed at the top with a two-holed rubber stopper. In the stopper is inserted the glass funnel and glass tubing which is connected with the jug containing the sterilizing solution, *A*. In the middle of the chamber is a rubber stopper (Fig. 3, *C-2*), which has been reamed out so that its walls are about three millimeters thick. A string is fastened to the stopper by means of a small strip of wood. The top of the stopper is covered with close-meshed gauze, upon which the eggs collect. The bottom of the chamber is closed with a one-holed stopper (Fig. 3, *C-3*), through which projects a piece of glass tubing.

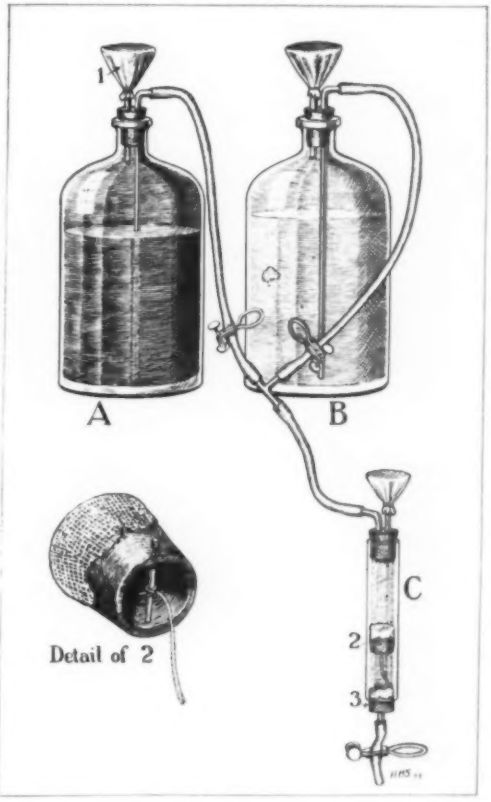

FIG. 3

Sterilization apparatus:
A. Formalin—sterilizing solution.
B. Sodium chloride solution—washing fluid.
C. Sterilization chamber.

B and *C* are sterilized separately.

The advantage of this sterilization set-up is that no air can come in contact with the fluid or the eggs without first being filtered, thus reducing the risk of contamination to a minimum.

Technique: The top stopper of the sterilizing chamber is removed, and the eggs are poured in. The sodium chloride solution runs out through

the bottom of the chamber, and the eggs are caught on the gauze covering the middle stopper. Formalin is run in slowly until it fills the entire chamber. It is then run in and out several times in order to agitate the eggs. After a five-minute period, the formalin is run out and a 0.85 per cent. solution of sodium chloride is run in. The formalin is colored with methylene blue merely to indicate when the eggs are free of formalin in the washing process. Any eggs that may be caught on the sides of the chamber are washed down by tilting the chamber so that the entering stream of washing solution plays directly upon them. After the washing process is completed, the stopper is removed and the lip of the tube is flamed. The middle stopper is pulled down by the attached string, the lip of the tube is again flamed, and the middle stopper is pulled out. The gauze, with the eggs attached, is transferred aseptically to a four-ounce specimen bottle (Fig. 4).*

FIG. 4

Specimen bottle, containing sterile whole egg.

The entire process of sterilization is completed by one person in approximately eight minutes. The volume of eggs sterilized at one time is about one cubic centimeter. It has been found that one-tenth of a cubic centimeter contains approximately 500 eggs.

CULTIVATION OF STERILE MAGGOTS

The eggs are incubated at thirty-seven degrees centigrade in order to permit any bacteria which may be present ample opportunity to grow. Each specimen bottle contains ten cubic centimeters of a mixture of equal parts of whole egg and 0.85 per cent. sodium chloride solution which has been placed in a bath of boiling water to allow the egg to coagulate. The egg is then broken up. A small piece of gauze, soaked in 0.85 per cent. sodium chloride solution, is placed in the specimen bottle which is closed with a perforated metal screw cap packed with cotton. The bottle is then sterilized. Contrary to the observation of Buchman and Blair [12] that maggots will not live on autoclaved egg, we have found that sterile maggots liquefy the egg only if the surface has been broken up. The bottles are placed in a glass jar containing water-soaked gauze to keep the air moist.

We are able to control the growth of the maggots by limiting the quantity of media to a definite amount for a definite quantity of eggs. When the maggots are from two to three millimeters in length, they are ready for use. They are tested for sterility from twenty-four to thirty-six hours after hatching. Several maggots are transferred to the following media: one per cent. dextrose blood agar, one per cent. dextrose brain broth, and meat mash covered with vaselin. The maggots are kept in the

* In order to minimize the risk of contamination during the sterilization process, we wrap the lower quarter of the chamber in paper, which is removed when the eggs are taken out.

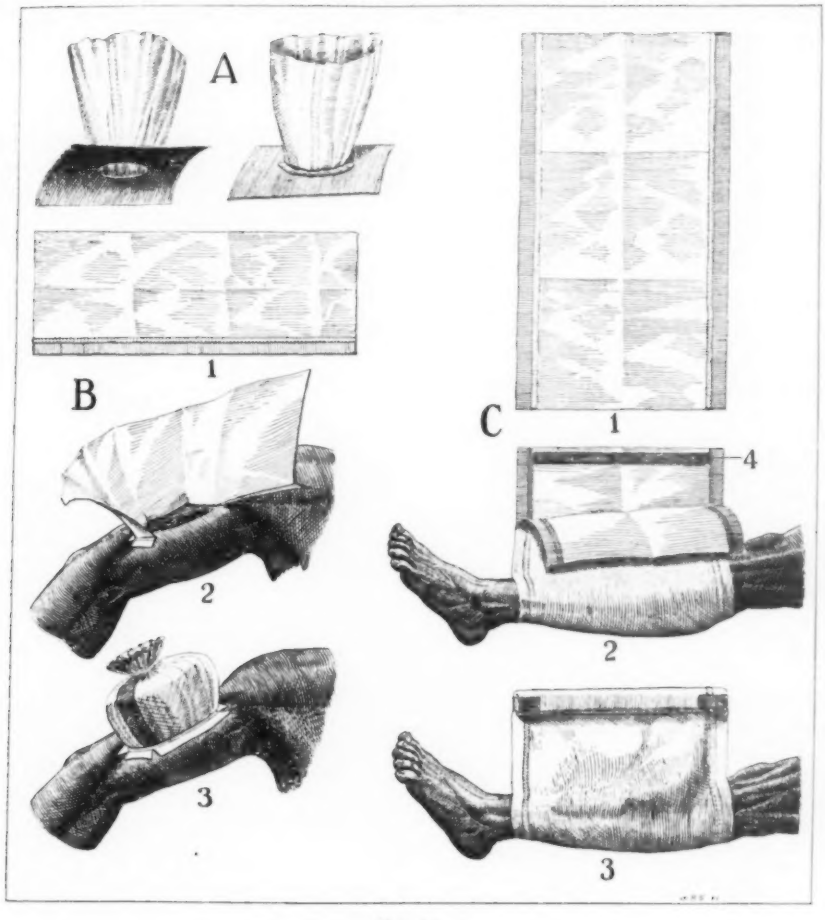

FIG. 5

Drawing of three types of maggot cages.

ice-box and, if growth is observed within forty-eight hours, this particular batch of maggots is discarded.* We have also noticed that, if a specimen bottle has an odor, the batch of maggots which it contains is invariably non-sterile.

By the use of the sterilization technique just described, more than eighty per cent. of the maggots are rendered sterile.

METHOD OF APPLICATION OF MAGGOTS TO WOUNDS

We use three types of cages. Type *A* (Fig. 5) has been used in cases of osteitis of the jaw and other small wounds. It consists of a sheet of adhesive tape in which is cut an opening slightly larger than the wound. A sleeve from six to eight inches long, made from ordinary sheeting, is

* As an added precaution, antitetanic serum is routinely administered to patients undergoing treatment.

sewed to the adhesive tape around the margin of the opening. Figure 6 shows the cage in place.

Type *B* (Fig. 5) consists of a piece of sheeting, ten inches wide, to which is sewed a narrow strip of adhesive tape (*B-1*). *B-2* and *B-3* show the method of applying the cage. Type *B* may be used for almost any wound.

Type *C*, which is used for very extensive wounds of the limbs, consists of a piece of sheeting, to which is sewed two strips of adhesive tape. The cage is closed by rolling the free end on a stick (*C-4*), or by tying it.

We found that it was very difficult to remove the sizing after the cage had been autoclaved. We have overcome this difficulty in the following manner: the sizing is removed; some crinoline gauze is placed loosely over the bare adhesive tape; and then the cage is autoclaved.

The edges of the wound are cleaned with ether and alcohol. We have found that the cage adheres better if some ordinary rubber cement is spread on the skin according to the directions on the tube.

The cage is applied and a thin layer of gauze is placed over the wound. The maggots are removed from the specimen bottle by picking up the gauze with sterile forceps and wiping it around the sides. This mops up most of the maggots. If any are left, fresh gauze is placed in the bottle and the procedure repeated. A large quantity of gauze is now placed on top of the maggots to absorb the exudate which later forms. The cage is closed by tying it at the top (*B-3*). All cages are reinforced with adhesive tape. We have found it necessary to replace the exudate-soaked gauze at intervals of about twenty-four hours, and at this time, if it seems necessary, the cage is further reinforced with adhesive tape.

We have found all three types of cages to be very satisfactory. The maggots rarely escape. The cage has been left in place for as long as ten days, fresh maggots being applied when necessary. Occasionally, we have permitted ambulatory patients to go home with the cage in place.

Many workers stress the necessity of light and air for the well-being of the maggots. Our experience has convinced us that mortality among the maggots is due to drowning in exudate rather than to lack of light or air. As a matter of fact, we have rarely found any dead maggots in a wound.

ACTION OF MAGGOTS IN THE WOUND

The maggots have no difficulty in penetrating the gauze in order to reach the wound. In one of our experiments, freshly hatched maggots penetrated a thickness of five inches of dry, closely packed gauze in order to reach their food. When they are full grown, they leave the wound and enter the gauze for the purpose of pupating. They are then removed with the waste gauze which has become soaked with exudate.

Our cages permit inspection of the maggots at work in the wound, and some interesting observations have been made. In the case of an

abscess of soft tissue, which we had opened by making a small stab wound, the maggots spread the opening apart by wedging themselves into it. The entire cavity was filled with maggots, with only the tails showing. Now and again, one would back out and another would take its place. At the end of twenty-four to forty-eight hours, the activity of the maggots is greatest, and the wound looks clean. At the end of seventy-two hours, exudate has accumulated, as the maggots have ceased to feed. At this time, fresh maggots may be placed in the cage.

The action of the maggots is twofold: (1) they perform a rapid and thorough débridement when used in sufficient numbers; (2) they stimulate the formation of granulation tissue. It has been noted that, after débridement has been accomplished, a slight amount of bleeding occurs, and, at this time, the patient's discomfort reaches the maximum. The maggots require more than forty-eight hours to reach full size. In soft-tissue infections, two or three applications are sufficient for complete débridement; in osteomyelitis many more applications are necessary. When débridement is complete, fewer maggots are used, and their function at this time is to keep the wound clean and to promote healing. Maggots do not digest dead bone, but in our opinion they definitely hasten sequestration.

FIG. 6

Case 4. Photograph showing Type *A* cage in place in the treatment of osteitis of the jaw.

No difficulty is experienced in removing the maggots from the wound, because, when they are fully grown, they burrow into the gauze. Washing the wound with sodium chloride solution is, therefore, unnecessary, and if, as Livingston and Prince [15] have reported, an active principle is liberated by the maggots, it is thus preserved. During the time when the maggots are active in the wound, the patient's temperature frequently rises from two to four degrees. This we attribute to the absorption of liquefied necrotic tissue. Pitting oedema around the wound is sometimes seen during the first day or two, but subsides on the third or fourth day.

RENEWAL OF LAYING STOCK

At the beginning of our work, we obtained additional flies by growing maggots in jars containing meat, as previously described. This method has since been discarded as it is space-consuming and the odor is objectionable.

The gauze and maggots which are removed from the wound are

collected in paper bags and placed in a large can covered with sheeting. At the end of three or four days, most of the maggots have pupated. The pupae are shaken out of the gauze and stored in the ice-box, or allowed to hatch, depending upon the need for additional flies. This procedure enables us to check up possible contamination by other species of flies. Furthermore, it eliminates the need for fume closets.

CLINICAL APPLICATION

During the past six months, twenty-nine cases have been treated by maggot therapy. These include: (1) *soft-tissue infections*—three cases of carbuncle, two cases of traumatic injuries, two cases of decubitus; (2) *compound fractures*—five cases, three of which were caused by gunshot wounds; (3) *bone infections*—one case of chronic osteomyelitis of the skull, eleven cases of infection of the long bones, two cases of infection of the foot, and three cases of osteitis of the jaw.

It was found that maggot therapy proved particularly effective in soft-tissue infections. The following cases are described in order to illustrate the versatility of maggot therapy and the adaptability of the cages to various types of infected wounds.

CASE 1. W. C., a white man, diabetic, sixty-nine years of age, was admitted with a carbuncle on the back of the neck, of two weeks' duration. No improvement resulted from incision and application of moist compresses. Two batches of maggots were applied, the patient being ambulatory throughout treatment, and the carbuncle was healed in twelve days.

CASE 2. A. S., a white man, twenty-one years of age, was admitted with laceration and contusion of the forearm. Little improvement was noted after treatment with hot

FIG. 7

Case 3. Photograph showing wound in osteomyelitis of the skull.

FIG. 8

Case 3. Photograph showing Type *B* cage in place.

compresses of magnesium sulphate and injections of staphylococcus and streptococcus bacteriophage. An area of ulceration, about six centimeters in diameter, was present on the outer side of the forearm, and the skin about the ulcer was undermined to a distance of about three centimeters. Numerous superficial ulcers were present. Following the application of two batches of maggots, healing was practically complete after nine days.

CASE 3. S. J., a colored man, twenty-nine years of age, was admitted with a condition diagnosed as osteomyelitis of the frontal bone. In the course of three operations, portions of the frontal and parietal bones were removed.

The wound did not heal, and maggot therapy was instituted (Figs. 7 and 8). Ten batches of maggots were applied, after which a roentgenogram showed some diseased bone still present. The patient refused further operation and was discharged with a hopeless prognosis.

The case just presented illustrates the adaptability of our cages. Both *A* and *B* types were used, and very few maggots escaped. As far as we have been able to ascertain, this is the first case of osteomyelitis of the skull in which maggot therapy has been attempted. Wilensky [16], in a very thorough article on osteomyelitis of the skull, suggested this method of treatment. The possibility that the maggots may penetrate the dura, which has been mentioned by some writers, is more theoretical than real, as in these cases the dura is very much thickened.

CASE 4. R. G., a white boy, three years of age, was admitted with a condition diagnosed as chronic osteomyelitis of the left mandible. A draining sinus was present. The bone did not heal after curettage. About six months later, another operation was performed and eight days afterward maggots were applied, using the Type *A* cage (Fig. 6). The maggots were removed after three days. Two weeks later, the wound was completely healed.

This case again illustrates the adaptability of our cages to this type of wound. The patient was ambulatory and was unaware of the type of treatment. Two similar cases have since been completely cured.

SUMMARY

We have developed a technique of maggot culture and application which we believe greatly simplifies maggot therapy.

With this technique, one worker can rear enough maggots to treat some fifty patients at one time.

By means of cages such as we suggest, maggots may be confined to any type of wound on the exterior of the body.

Maggot-treated wounds need attention only once or twice in twenty-four hours, dependent drainage not being necessary.

If our methods are followed, the maggots will not die in the wounds.

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A REPORT OF FORTY CASES OF FRACTURE OF THE VERTEBRAE WITHOUT CORD SYMPTOMS *

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A study of the literature on fracture of the spine without cord symptoms shows great variations in the method of treatment and the period of hospitalization, but unfortunately leaves us in doubt as to the results obtained. It is the purpose of this paper to add to the literature a report of forty cases of fractured vertebrae without cord symptoms with the mode of treatment instituted and the results obtained, as far as they could be determined.

In four years (1924 to 1928) forty cases of this kind were observed at the Cincinnati General Hospital. With the exception of one, all of these cases were recent fractures, and the majority of these patients were brought to the Hospital immediately following the injury. Suspicious fractures of the spine are not included in this résumé; in each case the diagnosis was confirmed by x-ray.

Symptoms and Physical Findings:

The most constant single clinical sign in establishing the diagnosis of fracture of the vertebrae without cord symptoms is local pain with point tenderness. Every case but one of our series presented this symptom. Disability ranks second to pain in frequency. Several patients complained of inability to walk, and an analysis of our cases shows this disability to have been present in ninety per cent. Four patients walked into the Hospital; two patients were in a severe grade of shock but they had many associated injuries. A careful study of the clinical description and the pulse and temperature charts fails to reveal shock in the majority of our cases. Two patients were unconscious on admission; both had associated head injuries.

Referred Pain:

As far as our records show, four patients had pain referred to the posterior aspects of the thighs, and ten complained of mild abdominal pain. In one case of fracture of the ninth dorsal vertebra, the patient complained of difficult and painful respiration. He was slightly cyanotic; his respirations were rapid and shallow; but there was no definite evidence of fracture of the ribs or of an intrathoracic injury.

Deformity:

Kyphosis in a mild form was noted in but four cases.

* The cases reported were treated in the General Surgical Service of the Cincinnati General Hospital, with which institution the author was associated. His thanks are due this institution for permission to publish the study made there.

Crepitus:

In the cases with a fracture of the transverse processes it was possible to demonstrate crepitus in three.

Site of Lesion:

It has often been observed that the upper lumbar spine is the site of fracture in the majority of cases of fractured vertebrae. The first three lumbar vertebrae were fractured in thirty-seven of our forty cases. The distribution of the fractures with regard to individual vertebrae is as follows: second cervical, two; third cervical, two; fourth, fifth, and sixth cervicals, each one; ninth dorsal vertebra, two; and twelfth dorsal vertebra, three. In contrast with the cervical and dorsal vertebrae, the first lumbar vertebra was fractured in twelve instances; the second in fifteen; the third in ten; the fourth in five; and the fifth in three instances. In twenty-nine of the forty cases the fractures were crushing fractures of the vertebral body. In eleven cases the fractures were of the transverse processes only. There were ten cases in which more than one vertebra was fractured.

Treatment:

The treatment for the majority of cases consisted of immobilization of the spine in hyperextension for a period of six weeks. Following this period, a supporting back brace was applied, which was worn by the patient for a period of from six weeks to one year, depending upon the residue of pain, weakness, and disability. The type of brace used by preference was the Taylor back brace.

In thirty of the forty cases a body cast was applied. Five cases were treated by bed rest alone. Three of these patients had fractures of the transverse processes alone, and after six weeks in bed they were sent home without a back brace. They were advised to return to the Clinic if symptoms recurred, but none have returned. Five patients were sent home in casts and returned to the Clinic for removal of the casts and for application of the brace. Two patients left the Hospital before the institution of treatment.

Hospitalization:

The average number of hospital days for this group of patients was forty-four. The longest stay in the hospital for any one patient was sixty days.

Results:

It has been possible to follow thoroughly twenty-two of the forty cases. These have been observed for from two to five years following the injury.

Deaths:

No patient died directly from the injury. Two patients have died since leaving the Hospital, one of pneumonia in a neuropathic hospital, two months after discharge; the other of "heart failure", according to the relatives, four months after discharge.

Late Results of Fracture of the Transverse Processes:

Four of the eleven cases have been observed. Three of these patients are absolutely well; they have no pain or weakness; and examination of the back is negative at this time. The fourth patient complains of stiffness in the lumbosacral region and of pain in both buttocks. This patient had a fractured pelvis and three fractured ribs, besides fractures of the transverse processes of the fourth lumbar vertebra.

Late Results in the Crushing Fractures of the Lumbar and Dorsal Vertebrae:

Fifteen of these cases have been observed for from two to five years following the injury. Four of these patients are absolutely well; they have no pain in the back, no weakness, no disability; and physical examination is negative. Eleven patients complain of pain in the back upon lifting and stooping, and of weakness of the back. In ten of these cases the symptoms are said to be severe and in one mild.

Occupational Results:

No patient is totally incapacitated. Four patients of the entire group, excluding the two who died following discharge, have not been able to return to their regular work on account of residual disabilities from their injuries. The majority of the patients took up light work for a shorter or longer time following discharge. The average time for assuming light work following injury was nine months. The average time for return to regular duties was one year and two months. These figures do not include patients who did not return to their regular work.

This report shows, therefore, that thirty per cent. of the patients observed are free from symptoms and able to resume their regular work; twenty per cent. are thus far unable to take up their regular duties; seventy per cent. complain of symptoms which they state are a handicap in their work.

Examination:

The patients examined from two to five years after injury failed to show physical signs of the injury, with the exception of two. Both of these were cases of crushing fractures of the lumbar spine and presented point tenderness locally, slight limitation of motion, and definite but mild muscle spasm when motion was attempted. Definite kyphosis was present in these two.

SUMMARY

1. Fractures of the vertebrae without cord symptoms are the results of severe accidents affecting the upper lumbar spine in the majority of cases; and, although not to be compared in seriousness with those causing injury of the spinal cord, yet they are capable of producing distressing permanent symptoms.

2. Fractures of the transverse processes alone have, in this series, had practically no residual symptoms.

3. Seventy per cent. of the fractures of the crushing type in the dorsal and lumbar spine present pain in the back and weakness. A few of these patients are partially disabled.

4. No patient has been totally incapacitated due to the spinal injury. The average time of return to work following injury was from nine to fourteen months.

5. In view of these results, the question arises whether a longer period of primary immobilization would not yield better results.

NON-TUBERCULOUS INFECTIONS OF THE SPINE *

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Among the various infections of the spine, tuberculosis and chronic osteo-arthritis or spondylitis are usually recognizable with a fair degree of certainty by their roentgenographic appearance, and the clinical and roentgenographic diagnoses can usually be made with considerable assurance.

Other known types of infection of the spine are: osteomyelitis, typhoid arthritis, lues, Neisserian infection, fungus infections, undulant fever, and unclassified infectious arthritis. We believe that only with considerable difficulty and uncertainty can these be recognized and classified roentgenographically and clinically. In a recent article, Smith [1] calls attention to a benign form of osteomyelitis of the spine which is very difficult to distinguish from tuberculosis. In his series, eleven out of seventeen cases had been previously diagnosed as tuberculosis by competent orthopaedic surgeons.

We are here reporting four cases which we believe to be cases of non-tuberculous spine infection. We are presenting these, partly because they are of interest in themselves, and partly to illustrate the extreme difficulty in making a definite diagnosis in these types of cases. Our discussion of the following cases indicates that there is still some uncertainty in our minds with regard to the diagnoses.

CASE REPORTS

CASE 1. Mrs. H. S. T., a woman of middle age, was first seen by one of us (A. W.) August 21, 1929. At that time there was a history of an abrupt onset of pain in the back eighteen months before, while seated in a theater. The patient was ill for the next four to seven weeks with what eminent consultants called intestinal influenza. The Widal test and blood culture were negative for typhoid. Wassermann and gonorrhœal complement-fixation tests were negative. At that time, she complained of considerable pain and stiffness of the back, which gradually increased. Several months later, when her condition permitted, she went abroad and used mud baths and similar therapeutic measures. She returned home and was fairly comfortable, although her back was stiff. Two months later (sixteen months after the original onset), following a motor trip, she experienced great pain in the back and the stiffness became much worse. Pain was spasmodic in character and was severe enough to require one-quarter of a grain of morphine three times a day. She had been confined to her bed for two months when first seen by us. Her temperature ran between 99 and 101 degrees.

August 23, 1929: The patient was moved to a hospital, where, under general anaes-

* Read before the Annual Meeting of the Alumni Society of the Hospital for Ruptured and Crippled, November 13, 1933.

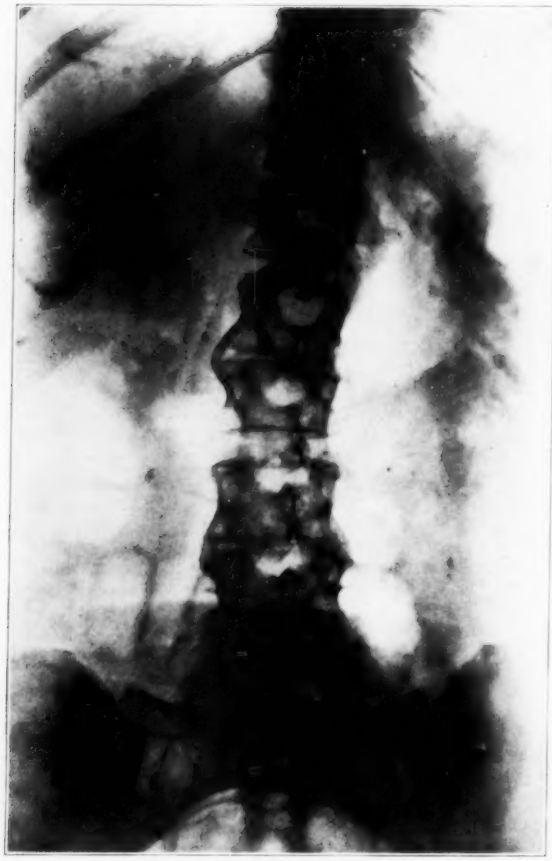

FIG. 1-A

Case 1. Mrs. H. S. T., September 9, 1931.

thesia, her back was stretched and placed in proper alignment, and a plaster jacket was applied. Operative fusion of the spine was refused by the patient.

September 24, 1929: Patient had had no pain for a week.

October 4, 1929: Patient was discharged wearing a plaster jacket.

January 17, 1930: The plaster jacket was removed and the patient was given a Knight spinal brace.

September 9, 1931: Roentgenograms of the lumbar spine (Figs. 1-A and 1-B) show six vertebrae of the lumbar type. The discs between the second and third and between the fourth and fifth bodies have been completely destroyed, and there is solid bony bridging between the adjacent margins of the second and third, and the fourth and fifth bodies.

September 24, 1931: Patient's back was stiff. Attempts at motion were not painful.

October 7, 1931: Patient went without a brace at night and in the forenoon, without pain. She has not been seen since and the consequent assumption is that she is well.

This case seems to belong either (1) to that broad and inclusive group called infectious arthritis, organism unknown, following what has been called, perhaps for lack of a better name, intestinal influenza; or (2) to the osteomyelitis group. It seems impossible to make a precise diagnosis of the spinal infection in this patient.

CASE 2. Mrs. C. G., aged twenty-nine, was seen first October 31, 1931, by Dr. L. C. Wagner. For a year previous she had had pain in the dorsal region about the right scapula. There was no history of injury. Her general condition was good.

Physical examination showed some stiffness of the neck and in flexion of the spine. Flexion of the neck caused pain around the lower border of the scapula and in the right breast.

Roentgenographic examination showed much narrowing of the intervertebral disc between the fifth and sixth dorsal vertebral bodies, with the narrowing a little more marked on the left side. There was no evidence of bone involvement.

Patient was given a Knight spinal brace, which she wore with relief of symptoms.

Roentgenographic examination on September 14, 1932, suggested a little bone proliferation on the left side (Figs. 2-A and 2-B).

There is no history of trauma to suggest injury to the nucleus pulposus of the intervertebral disc. The history, examination, and course do not suggest tuberculosis, although this cannot be excluded absolutely as a possibility. The most likely diagnosis would seem to be unclassified infectious arthritis.

FIG. 1-B

Case 1. Mrs. H. S. T., September 9, 1931.

CASE 3. Mr. C. F., aged twenty, was first seen on September 1, 1931. There was a history of severe aching pain in the lumbosacral region of two months' duration. There was no known etiology except overexertion brought about by lifting stones at a summer camp. There were no constitutional symptoms.

Roentgenographic examination, August 10, 1931, showed a rounded area of bone destruction and bone production at the anterior superior margin of the body of the third lumbar vertebra, and considerable narrowing of the disc between the second and third bodies (Figs. 3-A and 3-B).

Pain became worse during the following two weeks. There was no history of infection or venereal disease; no fever. Patient was confined to his bed, with considerable relief of symptoms.

October 21, 1931: A plaster jacket was applied and immediate relief was obtained. After two weeks in plaster, the patient was given a brace. His general condition was excellent.

September 8, 1932: Clinically, complete recovery had taken place. The roentgenogram (Fig. 4) showed a filling in with new bone of the area of bone destruction in the third lumbar body.

Despite the mildness of the local symptoms and the absence of constitutional symptoms, this is probably a case of low-grade pyogenic abscess of a vertebral body, with involvement of the intervertebral disc. Another possible diagnosis, injury and herniation of the nucleus pulposus of the intervertebral disc, seems less likely.

CASE 4.* Mr. H. W., aged twenty-two years, was first seen by Dr. Stewart on February 9, 1932. There was a history of four discharging sinuses:

Left groin, six years' duration
Lumbosacral region, five years' duration
Over right hip, six months' duration
Over right sacro-iliac region, six months' duration.

Eight years previously he had had many boils.

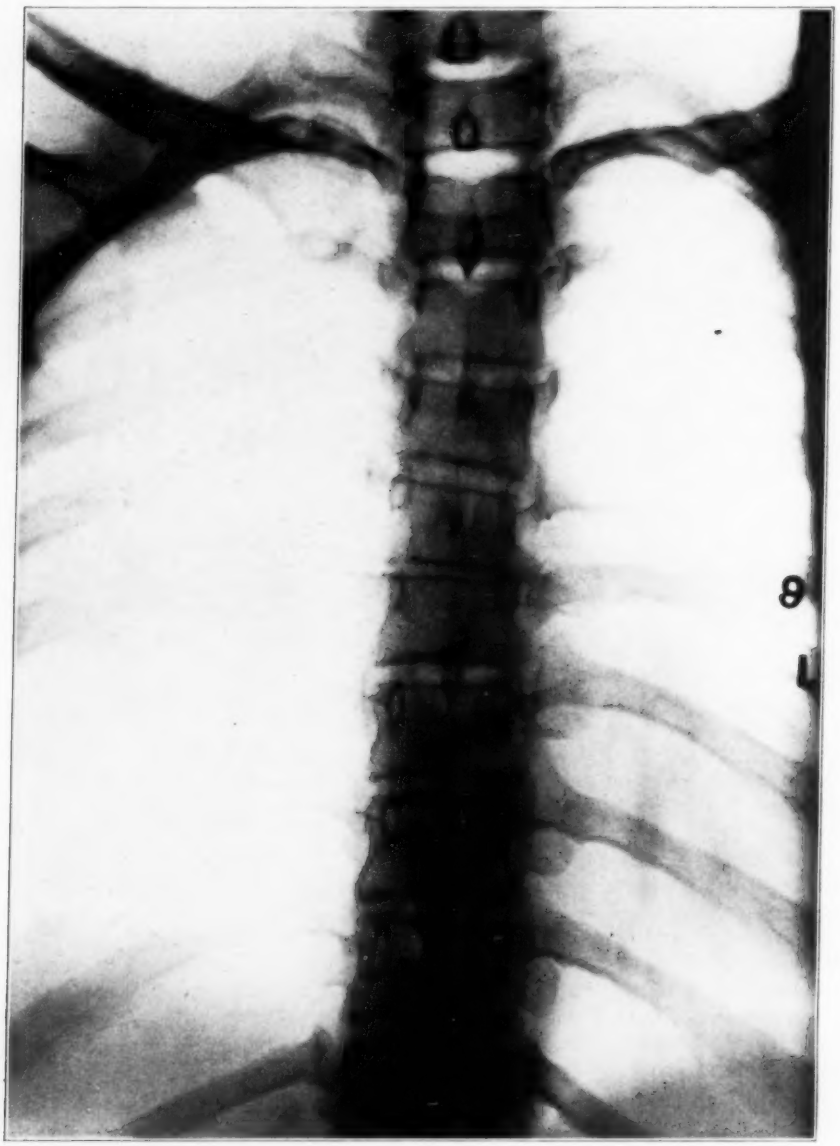

FIG. 2-A

Case 2. Mrs. C. G., September 14, 1932.

* This case is included through the courtesy of the late Dr. George David Stewart.

May 1924: Present illness began with a high temperature and severe pain in the small of the back. A so called cold abscess developed in the left groin, which disappeared in two months, following rest in bed and medical treatment.

November 1926: The cold abscess had reappeared, was opened, and is still draining.

May 1927: Another abscess was opened.

During 1929, the patient spent considerable time in the Desert Sanatorium. Repeated smears and cultures from the pus failed to show tubercle bacillus. Twenty or more guinea-pigs were injected with the pus, but showed no evidence of tuberculosis.

November 1930: Patient was confined to his bed with a high temperature and pain. One of the sinuses ruptured into the rectum. He was in bed for six months.

June 1931: Rollier's treatment was started.

July 1931: The abscess above the right hip was opened, and is still draining.

August 1931: The abscess over the right sacro-iliac region was opened, and is still draining.

On February 9, 1932, Dr. Stewart picked a small piece of bone out of one of the sinuses.

Roentgenographic examination, February 13, 1932, with injection of a twelve per cent. solution of sodium iodide into the sinuses, showed considerable narrowing of the intervertebral disc between the fourth and fifth lumbar bodies, slight roughening of the adjacent surfaces of these bodies, and erosion of the right transverse process of the fifth lumbar vertebra. A small sequestrum lay in the tissues lateral to the transverse process. The iodide showed that the sinuses led down to the right fifth lumbar transverse process, and to the right of the bodies of the fourth and fifth lumbar vertebrae.

On November 14, 1932, the roentgenographic examination showed conditions essentially the same as before (Figs. 5-A and 5-B).

FIG. 2-B

Case 2. Mrs. C. G., September 14, 1932.

The laboratory examination at the Desert Sanatorium and, especially, the findings obtained from the

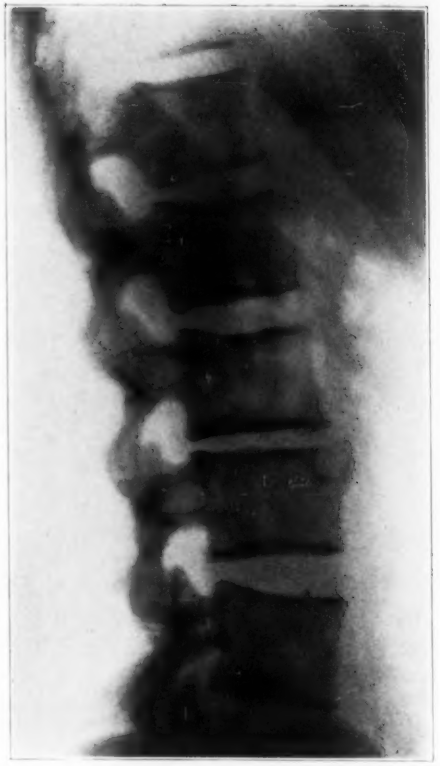

FIG. 3-A
Case 3. Mr. C. F., August 10, 1931.

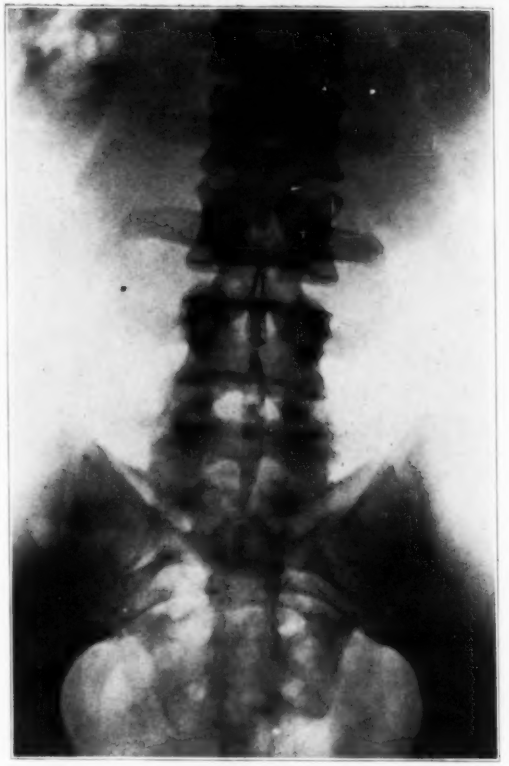

FIG. 3-B
Case 3. Mr. C. F., August 10, 1931.

FIG. 4
Case 3. Mr. C. F., September 8, 1932.

FIG. 5-A

Case 4. Mr. H. W., November 14, 1932.

FIG. 5-B

Case 4. Mr. H. W., November 14, 1932.

guinea-pig injections, seem to exclude tuberculosis. The history of boils prior to onset of the condition furnished a possible source of the spine infection. This case is probably a chronic non-tuberculous osteomyelitis and arthritis of the spine.

SUMMARY

1. Non-tuberculous infections of the spine are often difficult to diagnose as such, and their classification is frequently extremely difficult.

2. Four cases, believed to be non-tuberculous infections of the spine, are presented and discussed with regard to diagnosis.

1. SMITH, ALAN DEFOREST: A Benign Form of Osteomyelitis of the Spine. J. Am. Med. Assn., CI, 335, 1933.

SARCOMA FORMATION IN PAGET'S DISEASE OF BONE *

BY ROBERT PERLMAN, M.D., CINCINNATI, OHIO

Sarcoma formation is of relatively frequent occurrence in Paget's disease of bone. Diagnosis of the association of sarcoma and Paget's disease is usually made by clinical and roentgenographic findings. Case reports with a careful histological examination are infrequent. For this reason, it is deemed worth while to report the following case of Paget's disease with tumor formation. The correct diagnosis was made by microscopic study, but, unfortunately, clinical and roentgenographic data are not very complete.

CASE REPORT

The patient was a man, fifty-four years of age, who complained of pain and limitation of motion in the right knee joint. The trouble started many years ago, following a gonorrhoeal infection. The condition grew markedly worse a few months before admission to the hospital, and the patient became an almost total invalid. The right knee was very much deformed and contracted. The lower part of the femur was markedly enlarged and the superficial veins were distended. On motion, which was limited in every way, loud crepitation could be heard. The joint was hot and tender, and the leg was oedematous.

The anteroposterior and lateral views of the right knee joint (Figs. 1-A and 1-B), taken at the time of admission, show a very marked destructive lesion of the bone, especially of the lower end of the femur. The diaphysis is considerably thickened and the cortex on the inner side shows distinct lamellation. The marrow cavity is widened and crossed by some irregular bony trabeculae, which give a resemblance to a honey-combed structure. The outer cortex is destroyed for a distance of more than two inches and the adjacent bone of the epiphysis shows irregular osteoporosis. This osteoporosis is relatively more marked because almost the entire epiphysis, the subchondral zone of the lateral condyle in particular, shows definite osteosclerotic changes,—almost eburnation of the bone tissue. There is a distinct break in the continuity of the outline of the outer condyle, suggesting an old intra-articular fracture of the condyle. The bony changes in the tibia are less marked, involving mainly the subchondral zone. In this zone an irregular bony shadow is present, especially in the outer condyle. For the most part, however, the changes in the tibia are purely porotic. There is no decrease in the width of the joint space. There is swelling of the soft tissues, with a zone of irregular calcification, at the site of the more marked destruction of the cortex.

The patient was in the hospital only a few days. A short time after admission, he slipped and fell and thereafter was not able to walk. There was marked tenderness over the knee joint, which was suggestive of a supracondylar fracture, and the leg was immobilized. An empyema of the right pleural cavity followed, and the patient died a few days later.

Post-mortem examination showed a very extensive tumor formation in the distal end of the right femur and, also, a pathological supracondylar fracture. The section of tumor tissue (Fig. 2) shows large areas of necrosis. The tumor tissue invades the marrow cavity and the knee joint along the crucial ligaments and forms a thick layer over the semilunar cartilages (Fig. 3). On the anterior and lateral sides of the femur, the cortex has become destroyed by the tumor tissue. In other areas, the cortex is thick, but

*From the Department of Orthopaedic Surgery, State University of Iowa, Service of Dr. Arthur Steindler.

FIG. 1-A

FIG. 1-B

Anteroposterior and lateral views of the right knee joint showing, in addition to the typical changes of osteitis deformans, a destructive lesion on the anterolateral aspect of the lower end of the femur. The cortical bone in this area is markedly destroyed and the focus is surrounded by almost eburnated bone tissue. The intra-articular fracture of the lateral condyle is readily seen in the anteroposterior view.

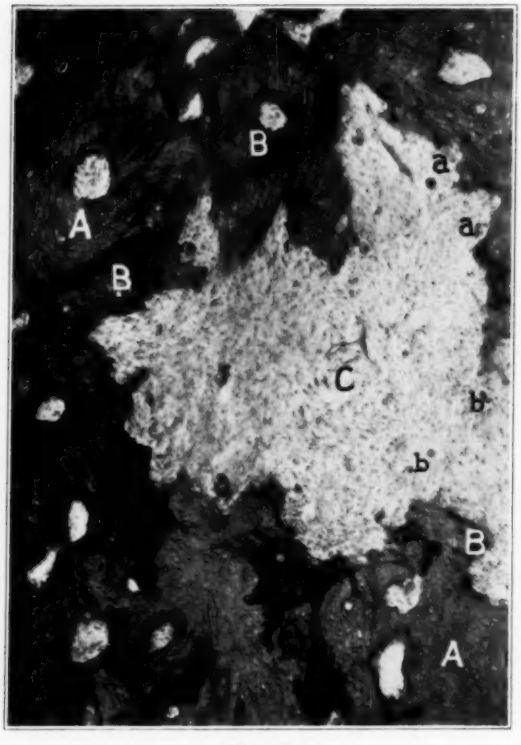

FIG. 2

Photomicrograph showing markedly sclerotic, necrotic Paget's bone of primitive character (*A*), with large basophilic portion, suggesting mosaic structure (*B*). By osteoclastic bone resorption (*a*), the enlarged marrow space (*C*) is filled with dense fibrous marrow containing free giant cells (*b*).

markedly porotic, and has the structure and the consistency of soapstone. The periosteum seems to be thickened and, in many places, to be involved by tumor tissue. The bone tissue in the epiphysis shows unusual sclerosis, but almost all of this sclerotic bone appears to be necrotic.

There was invasion of the popliteal vein by tumor tissue, and tumor emboli were found in many branches of the pulmonary artery. A fibrinopurulent pleurisy was found over the left lower lobe, and there was more than two liters of exudate in the right pleural cavity. There existed a purulent infarction in the right lower lobe, with necrosis of the pleura and empyema. There was present, by transmigration, a fresh fibrinopurulent pericarditis. All of the other findings were essentially negative. Unfortunately no other parts of the skeleton were examined.

Parts of the lower end of the femur and of the upper end of the tibia were taken for histological examination. Fourteen different sites were studied, but only those facts which are of most interest will be mentioned.

All the sections show the typical picture of Paget's disease (Figs. 2, 3, 4, and 5).

The findings in the lower end of the femur were as follows: in most places, the bone shows an advanced stage of Paget's disease. The bony trabeculae are thick and irregular and are made up for the most part of lamellar bone. Thick dark-blue cement lines unite irregular lacunar pieces of lamellar and fibrous bone, thus giving rise to the mosaic structure of Schmorl, which is typical of Paget's disease. Where a more acute picture of Paget's disease is present, which is the case in the subperiosteal zone of the femur (Fig. 4) and in the peripheral parts of the condyles, we find a very dense cancellous bone formed by thin trabeculae of fibrous bone, partly calcified and in part still osteoid. These bony trabeculae are formed on the basis of the loose fibrous bone marrow, at first entirely without the participation of the osteoblasts. The osteoblasts appear somewhat later and lay down osteoid tissue on the surface of the fibrous bony trabeculae. But, at the same time, multinuclear cells (osteoclasts) can be

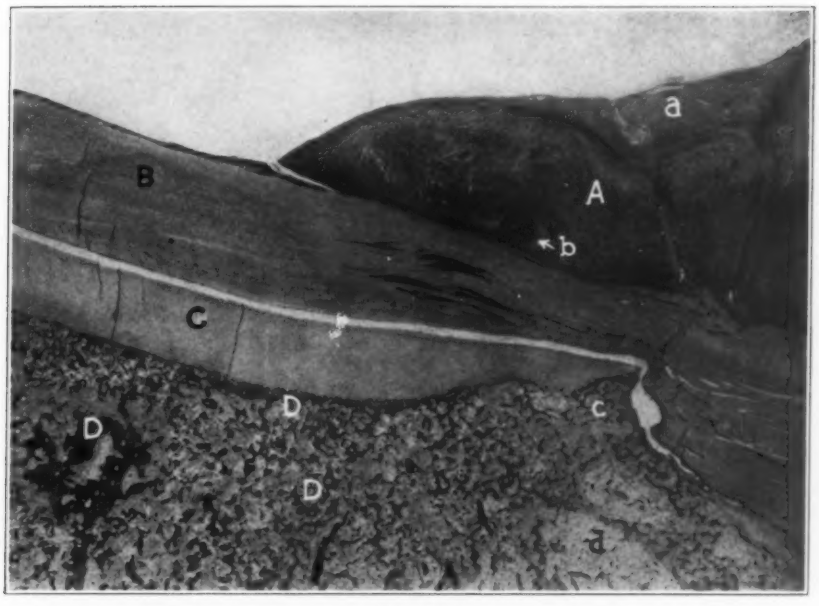

FIG. 3

Photomicrograph showing: invasion of the knee joint by tumor tissue (*A*), covering semilunar cartilage (*B*); a layer of fibrinous exudate (*a*); a tumor thrombus in the vein (*b*); normal joint cartilage of the tibia (*C*); subchondral zone (*D*) with Paget's bone in fibrous bone marrow, forming small marginal exostosis (*c*); normal fatty bone marrow (*d*).

observed bringing about lacunar resorption of the newly formed bony trabeculae. These rapid changes of bone formation, bone apposition, and bone resorption finally lead to the complex picture of Paget's bone. Depending upon whether bone apposition or bone resorption is in the preponderance, osteosclerosis or osteoporosis, respectively, will result. In some areas the activity of the osteoclasts is so pronounced that the bony tissues become absorbed in a very extensive way. This resorption may be so great that, in a roentgenogram, these areas may even appear cyst-like,—pseudocyst in Paget's disease[1]. In those areas where bone apposition is prevalent, the histological picture is more quiescent; the surface of the bony trabeculae is smooth, surrounded by osteoblasts with osteoid tissue; and lamellar bone is by far more prevalent than fibrous bone. There can result very marked osteosclerosis, with islands of almost compact bone within the spongiosa. From the pathological point of view, these photomicrographs may be interpreted as showing a healing stage of Paget's disease.

The picture is considerably different in the upper end of the tibia (Fig. 3). Here, the changes are undoubtedly of more recent character. They are florid in the subperiosteal zones and are more porotic in character in the middle of the epiphysis. The bony trabeculae show a composite character,—*i.e.*, several smaller bony trabeculae, with a typical picture of Paget's bone, are joined together by strips of fibrous marrow. The wide

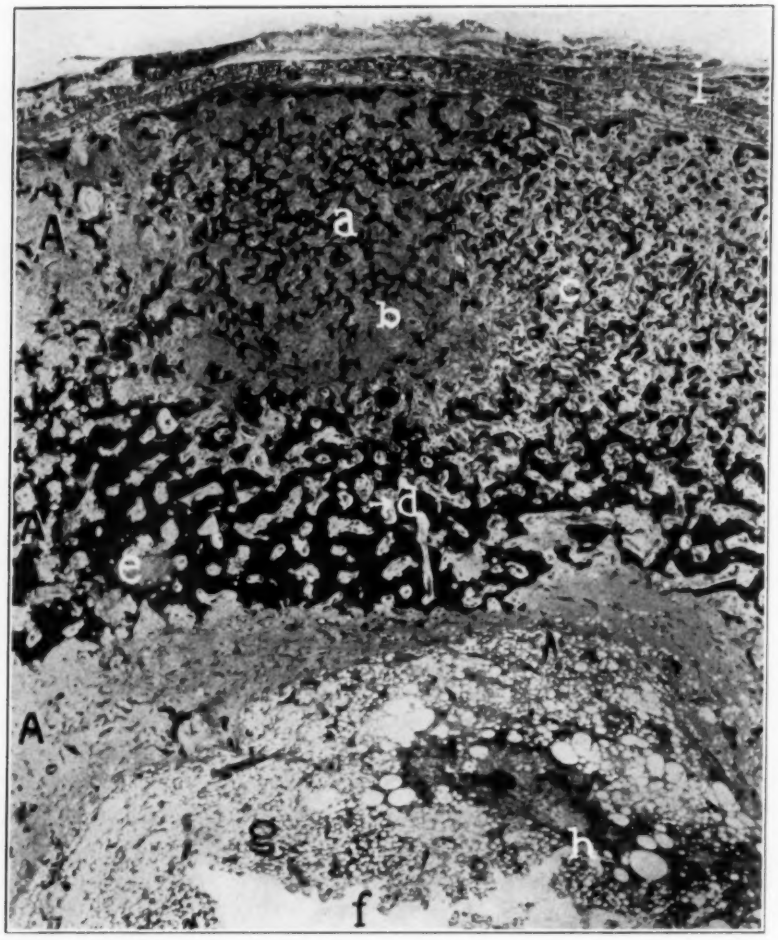

FIG. 4

Cross section through the femoral diaphysis showing: hyperostotic, porotic changes of cortical bone (*A*); subperiosteal zone (*a*) with small bony trabeculae in dense (*b*) and loose (*c*) fibrous bone marrow; more dense cortical bone (*d*) with focus of beginning sarcoma formation (*e*); marrow cavity (*f*) with fatty bone marrow (*g*), showing necrotic tumor tissue (*h*); a thin layer of periosteum with atrophic musculature (*i*).

marrow spaces between these strips are filled with perfectly normal cellular and fatty bone marrow. In these areas, which apparently show earlier stages of Paget's disease, some difference in the arrangement of the bony trabeculae can be noted in various places, a difference which very likely is founded on a mechanical basis. The area adjacent to the insertion of the crucial ligaments, for instance, shows a more advanced picture of Paget's disease and a denser bony structure. It is known from the investigations of Schmorl and Freund that areas with more marked mechanical irritation show the changes of Paget's disease first, such as the zones directly below and above the intervertebral discs. In our case a static structure of

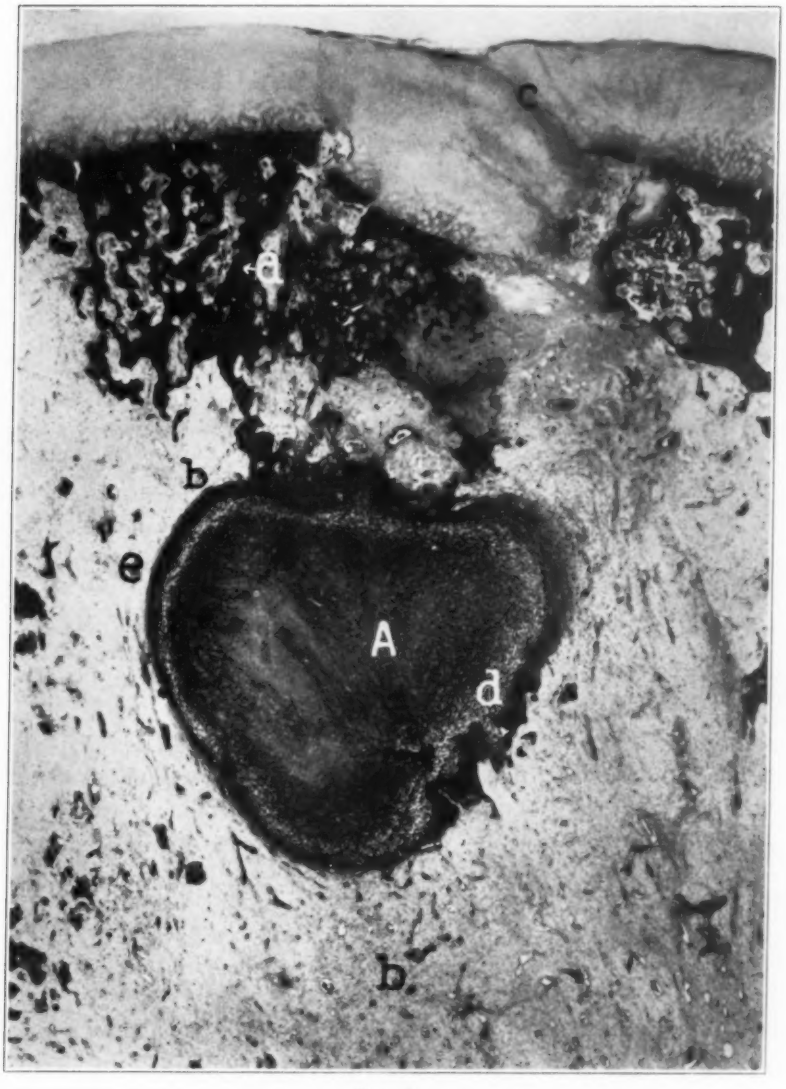

FIG. 5

Photomicrograph showing tumor nodule (*A*) in the subchondral zone of the lateral femoral condyle; marked osteoporosis, with subchondral Paget's bone (*a*) and fibrous bone marrow (*b*); fracture (*c*) of joint cartilage with downward displacement of one fragment and overlapping of the other.

The tumor nodule shows a central portion, with typical structure of spindle-cell sarcoma, and a more peripheral portion (*d*), which is cellular. A tumor capsule is formed by the surrounding bone marrow (*e*).

Paget's bone can be seen in the upper end of the tibia, which bone as a rule does not obey static laws. Here, the bony trabeculae show an extremely fine radial arrangement to the joint surface.

Differences can also be seen in the fibrous bone marrow. There is certainly not always the same picture with the same density of the fibers.

In places where the more acute changes occur, the bone marrow is rather loose (Fig. 4). In this loose bone marrow many blood vessels are seen, and in some places free red blood cells are visible in the tissues; in other places, there are found occasionally small islands of perivascular round-cell infiltration. In some areas the fibrous bone marrow includes small foci of fat cells which probably are remains of the old fatty bone marrow.

As the process goes on over a period of years, the fibrous bone marrow becomes more mature,—*i.e.*, the fibers are denser (Fig. 4), the marrow is less vascular, and the number of cells is decreasing. In the more central portion of the femoral diaphysis, close to the marrow cavity, extensive areas can be seen with marked hyaline degeneration of the fibers.

It is of great interest that tumor tissue can be seen only in places that show a highly mature fibrous marrow. The areas in which the fibrous marrow gives the impression of being young and active—where the typical florid picture of Paget's disease, with the small and dense trabeculae of fibrous bone, is seen—are free of any tumor tissue. It has already been mentioned that the tumor tissue showed extensive necrosis, due to the pathological fracture. This rendered the histological investigation a little more difficult, but a clear idea of the tumor growth was finally obtained.

Near the intercondyloid fossae of the femur the marrow spaces are filled with polymorphocellular tissue. The cells are large; the protoplasm is very light and almost foamy. The nuclei are of different sizes, but, in general, are large and poor in chromatin. Frequently, mitotic figures can be seen. Cells with two or more nuclei are not rare. In these marrow spaces very few fibers can be seen between the cells. There is, however, marked osteoclastic bone resorption going on around the endosteal surface of the marrow spaces.

In other places, the picture is quite different (Fig. 6). The cells show more uniformity, the nuclei are darker, the protoplasm is spindle-shaped, and between the cells connective-tissue fibers are present. Cells and fibers are arranged in bundles in which giant cells and mitotic figures are present frequently. These findings are very typical of a rather rapidly growing spindle-cell sarcoma; whereas the areas with the irregular and large protoplasmic cells correspond exactly to the description by von Albertini [2] of what he calls the "presarcomatous stage" of Paget's bone marrow.

From a careful study of different sites in the femoral diaphysis, one gathers the impression that the tumor growth started independently at the same time in these different places (Figs. 4 and 5). There are two areas which point this out particularly well,—one a marrow space in the cortex of the diaphysis; the other in the subchondral zone of the lateral femoral condyle. The first area shows very active enlargement by osteoclasts. The marrow space is filled with a rather cellular tissue containing giant and spindle cells, and there is a beginning arrangement of fiber bundles. This marrow space stands out from the surrounding tissue and there can be no doubt that here sarcoma formation is just beginning.

This shows, however, that von Albertini's "presarcomatous stage" is not absolutely necessary in sarcoma formation in Paget's bone marrow.

The other area shows grossly a grayish-white, dry, and slightly granulated tumor nodule, which is sharply outlined (Fig. 5). Microscopically, the focus is composed for the most part of spindle cells, with fibers arranged in bundles. The central portion shows relatively more fibers and even hyaline degeneration of the fibers. Toward the periphery the cells are more prevalent. Here also, most of the cells are spindle-shaped, but among these there are quite a number of different cells, even giant cells, and mitoses are quite frequently found. The dense fibrous structure in the central portion loosens up almost immediately toward the periphery, the fibers are scarcer, and the cells become very protoplasmic and, by pressure, almost polygonal in shape. This layer corresponds to those cellular tumor areas already mentioned, the "presarcomatous stage" of von Albertini [2]. Where this cellular zone touches the bone marrow, the latter shows a kind of capsule formation, which, grossly, made the tumor nodule stand out sharply. This capsule formation is nothing more than the compression of the bone-marrow fibers by the expanding tumor growth. But it is interesting that the bone marrow near this zone is very rich in mononuclear cells with a reddish protoplasm. The nucleus is at the center or in the periphery and is smaller than in the polygonal cells in the tumor zone. These cells are histiocytes, furnished by the bone marrow, and they certainly represent a reaction to the tumor growth.

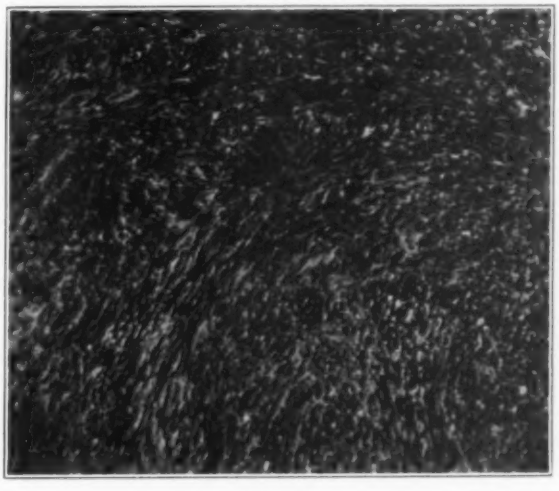

FIG. 6

Spindle-cell sarcoma with giant cells.

Because of its sharp outline, it may be that this tumor nodule represents a metastasis in the bone marrow rather than a primary tumor formation. But, inasmuch as there are several cases already reported to show that a multicentric tumor growth can take place in Paget's disease (von Albertini [2], Wanke [3], Schmorl [4]), we are also more inclined to this assumption in our case.

As already mentioned in the macroscopic description, the tumor in the lower end of the femur invaded the knee joint (Fig. 3). Despite extensive necrosis of the tumor tissue at this area, the structure is still

plainly visible. After osteoclastic removal of the bony lamellae in the intercondyloid fossae, the tumor followed closely the synovial layer along the crucial ligament. It grew along the ligament from femur to tibia and covered the semilunar cartilage in a thick layer. The superficial portions, which very likely received nutrition from the synovial fluid, are well preserved, whereas the deeper portions underwent necrosis. Where the necrosis of the tumor tissue in the knee joint is more extensive, the synovial membrane shows a marked degree of hyperaemia, with formation of granulation tissue, and the direction of almost all of the capillaries is toward the necrotic tumor tissue. The invasion of necrotic tumor tissue by newly formed granulation tissue represents the first attempt at a reorganizing process.

Of interest also are the changes in the knee joint, due to the intra-articular fracture (Fig. 5). The fracture of the cartilage occurred just over the area of marked osteoporosis in the central portion of the lateral femoral condyle, which showed also the sharply outlined tumor nodule. The highly porotic bone did not support the joint cartilage adequately, so that even a slight increase in intra-articular pressure could give rise to a displacement of joint cartilage toward the marrow spaces. And, as a matter of fact, a slight trough in the middle of the joint surface was found, which, macroscopically, did not look so deep because it was filled by a layer of coagulated fibrin in an advanced stage of organization. The depression is almost smoothed out by the superimposition of the cartilaginous fragments. More marked than the depression of the surface is the displacement of the deeper layers. This can clearly be judged by the discontinuity and the displacement of the subchondral hard substances. Instead of forming a continuous line, the zone of preparatory calcification and the subchondral bony lamellae show an abrupt interruption, and one fragment is displaced downward for almost two millimeters. There is no necrosis of the cartilage cells, but there are distinct changes in their structure. The displaced fragment of hyaline cartilage assumes a distinctly fibrous structure, with the direction of the fibers from the joint surface to the fibrous marrow. For mechanical reasons this corresponds to the "*Umprägung*" of hyaline cartilage (Schaffer). Along the fracture line, through the calcified cartilage and the underlying bony lamellae, the bone marrow comes in contact with the non-calcified cartilage. Here, the cartilage becomes invaded by bone marrow through an incomplete resorptive process described by Weichselbaum and Pommer. The hyaline ground substance of the cartilage disappears and the collagenous fibers of the cartilage become denuded. These fibers show, then, blending with the neighboring fibrous bone marrow, similar to the anchorage of fibrous tissue in bone shown by Sharpey's fibers. Inasmuch as by this resorptive process cartilage is not more completely lost, this fact may be interpreted, in this particular case, as an attempt at consolidation of the fracture of the joint cartilage by a rather firm union with the bone marrow.

CONCLUSIONS

A case of Paget's disease of bone is presented in which sarcoma formation occurred in the lower end of the femur, and, apparently, at the same time in other areas. The histological picture of the tumor varies from polymorphonuclear sarcoma to spindle-cell sarcoma and fibrosarcoma. The tumor led to pathological fracture at the lower end of the femur, and to invasion of the cavity of the knee joint and of the popliteal vein, with sarcoma metastases in the lungs.

It seems that osteitis fibrosa is the predisposing cause of the tumor growth, because only those portions with very mature fibrous bone marrow show tumor formation, whereas the parts with looser bone marrow and younger bony changes, in the sense of Paget's disease, are not affected by tumor growth. It is questionable whether von Albertini's distinction between a presarcomatous and a real sarcoma formation can be made.

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CORRECTION OF LATERAL COMPRESSION FRACTURE OF A LUMBAR VERTEBRA*

BY LEO MAYER, M.D., NEW YORK, N. Y.

Since 1927, when Arthur Davis, of Erie, Pennsylvania, demonstrated a method of correcting the anterior compression of the vertebral body in fractures of the spine, an extensive literature dealing with this topic has sprung into being. Despite the thoroughness with which the subject has been treated, no mention has thus far been made of the correction of a

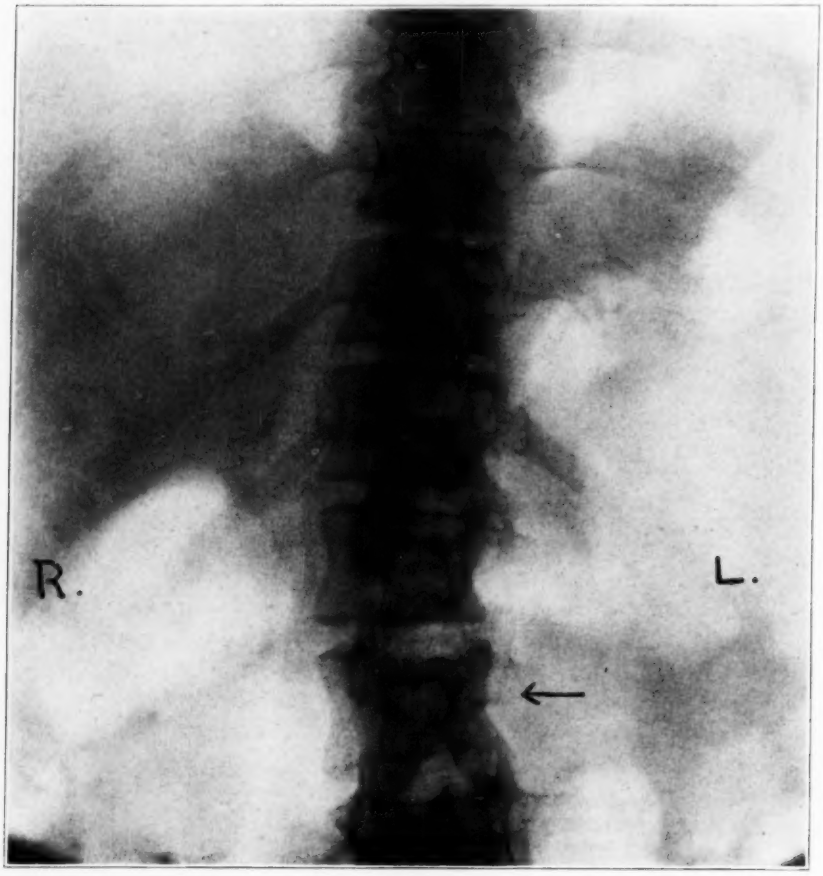

FIG. 1

Anteroposterior view of the lumbar and dorsal spine, one week after the accident. Note the compression of the left side of the second lumbar vertebra, as indicated by the arrow.

* Presented at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 10, 1934.

closely related deformity,—namely, lateral compression of a vertebral body. Though it is true that this type of compression is less frequent than the anterior type, its recognition and correction are equally important.

Just as anterior compression is usually caused by a force which doubles up the individual like a jack-knife, so the lateral compression is caused by a trauma which produces a sudden lateral impaction. It is seen most frequently in industrial accidents where the workman, in falling from a height, strikes an impediment—either a beam or a pipe—with the side of the body. But it can also occur as the result of less serious accidents, as in the following case.

CASE REPORT

Mrs. O. W., aged fifty-three years, was thrown from her horse and landed on her left side. Though suffering pain in the mid-spinal region and the lower left chest, she continued to be up and about. Thinking that she was merely bruised, she waited an entire week before consulting her physician.

When first seen by the author, eight days after the accident, the outstanding physical sign was a tilt of twenty degrees of the back toward the left. There was, in addition, marked tenderness in the region of the second lumbar vertebra, muscle spasm preventing motion of the lumbar and dorsal spine, and tenderness of the lower ribs on the left side. The reflexes were normal. There were no sensory changes. The patient had no bladder or rectal disturbances.

The lateral roentgenogram of the spine showed a fracture of the second lumbar vertebra (Fig. 2), with no compression of the anterior portion of the vertebra. The line of fracture ran from above downward and backward. In the anteroposterior view (Fig. 1) was seen a lateral tilting of the spine toward the left. This was

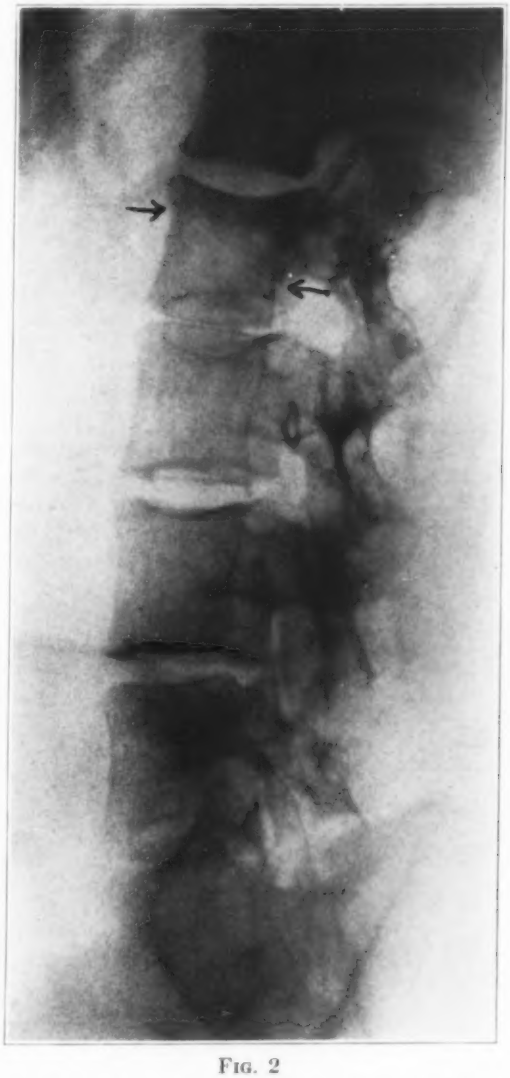

FIG. 2

Lateral view of the lumbar spine, one week after accident. The arrows indicate the direction of the line of fracture through the second lumbar vertebra. No anterior compression of the body is evident.

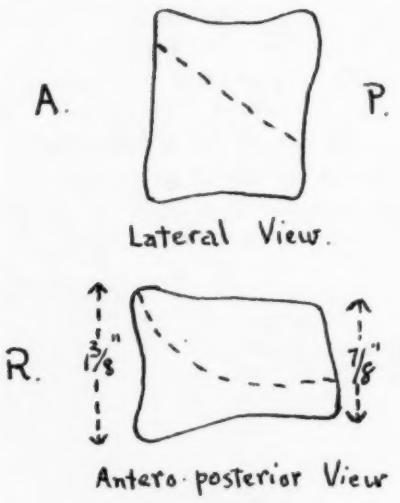

FIG. 3

Tracing of the lateral and anteroposterior roentgenograms, taken one week after the accident. The direction of the fracture is indicated by dotted lines. The left border of the second lumbar vertebra measures one-half an inch less than the right.

obviously due to the compression of the lateral half of the second lumbar vertebra. Measurements of the borders of the vertebra proved the left to be one-half an inch shorter than the right (Fig. 3). The line of fracture ran obliquely downward from the upper right corner of the body toward the lower left corner. Careful study of the film demonstrated increased density of the bone for about a half inch in the region of the fracture line. This was best seen near the left border of the vertebra, becoming less distinct as the fracture line was traced toward the right. It seemed reasonable to explain this increased density by an impaction of the two vertebral fragments. The articular processes of the left side, both the upper and the lower, showed a slight displacement, but there was visible no definite line of fracture running through the pedicles or laminae. The eleventh rib on the left side showed a comminuted fracture which had no clinical significance other than indicating the direction of the trauma.

It was obvious that the patient had suffered a fracture of the second lumbar vertebra, with a definite compression of the left side of the body.

Although the literature on fractures of the spine contained no allusion to the correction of this type of deformity, the author could see no reason why the impaction could not be reduced and the vertebral fragments maintained in alignment by a simple modification of the principles applicable to an anterior compression fracture. The all-im-

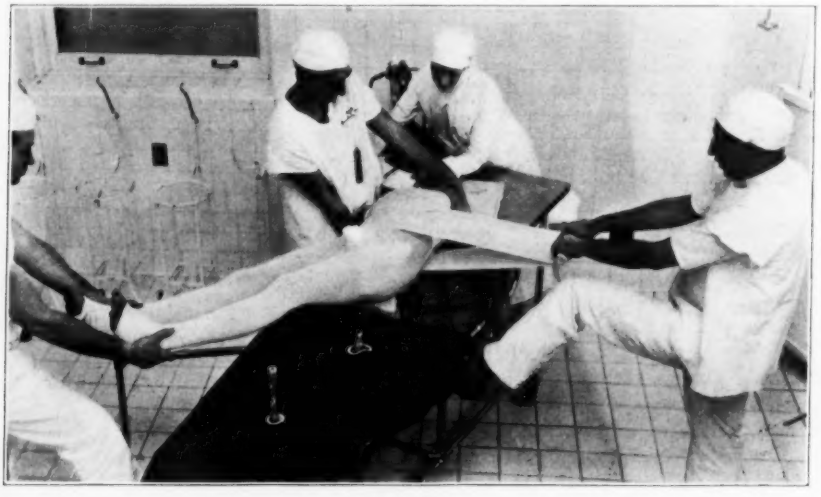

FIG. 4

Photograph indicating the manipulation employed to correct the compression of the left half of the second lumbar vertebra.

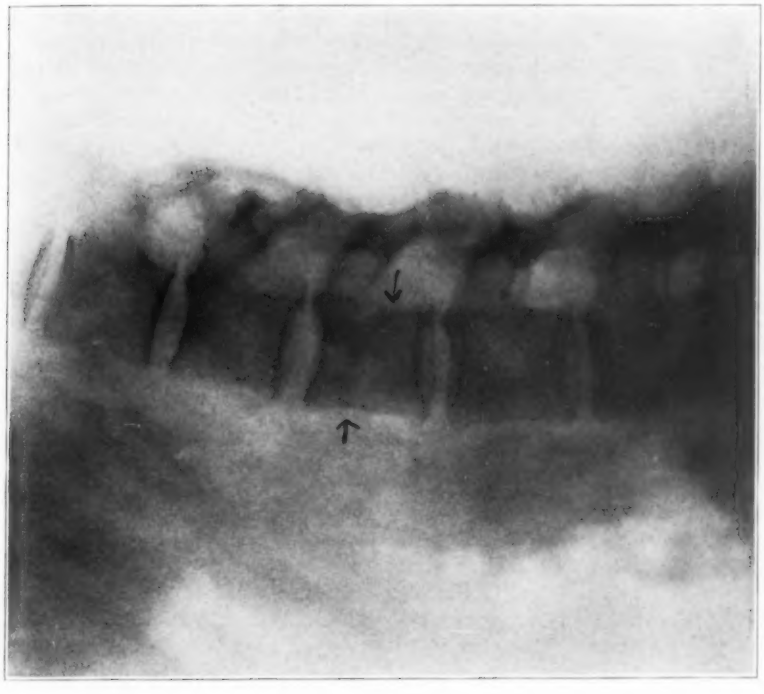

FIG. 6

Lateral view, taken four weeks after application of the corrective plaster-of-Paris jacket, showing the absence of deformity in this plane.

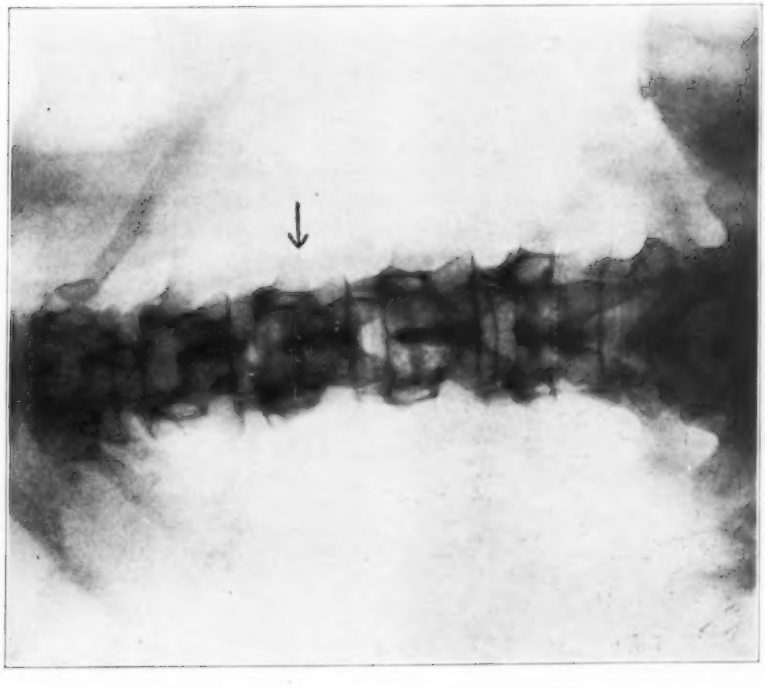

FIG. 5

Anteroposterior view of the lumbar spine, taken four weeks after the application of the corrective plaster-of-Paris cast. Note that the compression of the left half of the second lumbar vertebra has been entirely corrected.

portant fact demonstrated by Davis was that the intervertebral ligaments are strong enough, when tensed to their physiological limit, to disengage a recent vertebral impacted fracture. In the case of anterior compression, the anterior spinal ligament acts as the effective traction mechanism. If the compression is lateral, the ligaments joining the lateral portions of the vertebrae will, when stretched to their physiological limit, act to disengage the impacted fragments.

With this principle in mind, the following procedure was undertaken.

Although spinal anaesthesia might be used, avertin, supplemented by gas-oxygen, was administered to the patient. A stockinet undergarment covered both legs and the trunk. The patient's pelvis was placed on a hip rest, the legs and trunk supported by assistants. A piece of heavy felt, about a foot square, was placed on the patient's right side with its center at the level of the second lumbar vertebra. A broad muslin bandage was slung about the body to hold the felt pad in position, and the ends were wrapped about a stick to prevent wrinkling. One assistant then made traction on the muslin band toward the side of the compression, and a second assistant swung the legs and the pelvis in the opposite direction, thus fixing the distal fragment of the fractured vertebra. The disengagement of the impacted fragments was accomplished by slowly swinging the trunk away from the side of the compression until the limit of lateral mobility had been reached (Fig. 4). The body had thus been brought to form almost a semicircle, with the fractured vertebra situated near the middle of the arc. A roentgenogram, taken while the patient was held in this position, showed correction of the deformity of the second lumbar vertebra. With the patient in the position of maximum correction, a double plaster-of-Paris spica was applied from the knees to the axillae. This spica was left in place for one month and was then replaced by a lighter plaster spica which included the left thigh only. Two weeks later, with the body in the erect position, a plaster corset was applied and the patient was allowed to be out of bed for a few minutes each day. Gradually the period of weight-bearing was increased and, in addition, the patient was given abdominal and back exercises. Within two months from the reduction of the fracture, the patient was able to stand quite erect without any support (Fig. 7). Although she had no pain whatever, it seemed the part of wisdom to have her wear a light brace for another two months. The final result is shown in Figures 5, 6, and 7.

FIG. 7

Photograph of patient, eight weeks after the accident, showing complete correction of the lateral tilting of the body.

SUMMARY

A case of lateral compression fracture of the second lumbar vertebra is presented, in which complete permanent correction of the deformity was accomplished by manipulation and immobilization in plaster-of-Paris.

PATHOLOGICAL CHANGES OF MUSCLES IN THE COMMON DISEASES OF CHILDREN

Their Relationship to Scoliosis

BY JOHN G. KUHNS, M.D., BOSTON, MASSACHUSETTS

From the Department of Pathology of the Children's Hospital, Boston

Few diseases are limited, in the pathological changes which they produce, to one organ or to one tissue of the body. While the damage in some tissues may be slight and may be healed quickly, if the organism survives, the injury in other tissues may be more lasting, the severity of the injury usually being proportionate to the severity of the disease and the regenerative ability of the involved tissues. Where there is serious damage to the tissues, complete recovery often does not occur, and what repair takes place is often dependent upon careful guidance and the avoidance of undue strain upon the physiological function of that particular organ for a long period of time. Cardiac and renal tissues are among the more common examples of such damage following juvenile diseases.

It has long been known that extensive, pathological changes may occur in the skeletal musculature after certain infectious diseases. The muscles most frequently involved have been found to be the diaphragm and the rectus abdominis.[1] The pathological changes have been interpreted for the most part, not as direct infections by microorganisms, but as injuries due to an intoxication or other physiological disturbances subsequent to a systemic disease.[2]

In order to determine the frequency and severity of these muscular changes, an examination was made of the muscular tissue obtained at autopsy from 100 children varying in age from premature infants to fifteen years. Since the major interest lay in showing a possible relationship between these muscular changes and the development of scoliosis, the muscular tissue was taken from the muscle groups which support the spine,—the rectus abdominis, the iliopsoas, and the erector spinae. Transverse and longitudinal sections were cut from all specimens. These were stained routinely with hematoxylin and eosin. Duplicate sections were stained either with phosphotungstic acid or with Mallory's aniline blue to show connective-tissue fibers. A number of sections were stained by the Bielschowsky method of silver impregnation to show the myoneural junctions. No abnormal changes were observed in the nerves stained in this manner. The usual pathological changes found in the muscles were those called hyaline or Zenker's degeneration.[3, 4, 5]

A wide variation in the frequency and extent of these hyaline changes [6] has been observed.[7, 8] Zenker [3] found these changes almost constantly in typhoid fever and, more rarely, in other diseases in which the entire muscle

was sometimes involved. Stemmler [9], Wolbach [10], Forbus [11], and Stenström [12] found hyaline degeneration of skeletal muscles after severe illness, with occasional complete rupture of the rectus abdominis muscle. These changes in musculature have been seen also in anaphylaxis [13] and intoxication [1].

Other changes leading to temporary or permanent weakening of muscles following various diseases have been reported occasionally. Abscess formation [14], fibrosis [15], infectious myositis [16], syphilis [17], tuberculosis [18], and amyloid deposition [12] have been observed. Tumors [19] rarely metastasize to muscles, but frequently destroy musculature by direct extension. Bone [20] may form in muscle either by implantation of bone-forming cells or by direct metaplasia of muscular tissue. After prolonged dietary deficiencies [21], degeneration [22, 23] and fat deposition have been observed in the muscles.

All of these changes, except ossification and tuberculosis, were

TABLE I

STUDY OF MUSCULAR TISSUE OBTAINED FROM 100 CHILDREN AT AUTOPSY

Causes of Death	Range of Ages				Pathological Changes		
	Under One Year	One to Four Years	Four to Eight Years	Over Eight Years	Marked	Slight	Negative
Pneumonia and other pulmonary infections	15	9	1	0	4	15	6
Septicaemia and overwhelming infection	9	5	5	1	5	11	4
Prematurity and congenital malformations incompatible with life	13	0	0	0	0	5	8
Nutritional disturbances	7	3	1	0	1	6	4
Meningitis—influenza and meningococcus	2	3	1	0	0	3	3
Congenital heart disease	4	0	1	0	0	1	4
Congenital syphilis	5	0	0	0	1	4	0
Tuberculous meningitis	0	3	1	0	0	0	4
Blood diseases	2	1	0	0	0	2	1
Intracranial hemorrhage	2	0	0	0	0	1	1
Poliomyelitis	0	0	1	0	0	1	0
Tuberculous peritonitis	0	1	0	0	0	1	0
Craniopharyngioma	0	0	0	1	0	0	1
Nephritis	0	0	1	0	1	0	0
Rhabdomyosarcoma	0	1	0	0	1	0	0
Amyloid disease	0	0	0	1	1	0	0

observed in the muscular tissue studied in this series. In Table I, the diseases are grouped for convenience. No difference was observed between the muscular changes in boys and in girls; nor was any appreciable difference found in regard to age [12]. The pathological changes in the muscles were graded as marked, slight, or negative. Loss of striations in scattered muscle fibers or irregularity of staining without any other change were not considered to be of pathological significance.

FINDINGS

In twenty-five cases that came to autopsy, death was due to pulmonary infections. Of these, there were twenty cases of bronchopneumonia. The muscular tissue removed showed extensive hyaline degeneration in two cases and less severe degeneration in fourteen others. There were three autopsies performed on children who had died from empyema. Of these three children, one showed extensive muscular degeneration; another, slight muscular changes; and the third, no pathological changes in the muscles. The pathological picture which was usually most marked in the rectus abdominis muscle was similar to that described by Forbus[11], Stemmler [9], and Stenström [12]. Oedema was frequently observed, with loss of striations in various regions. There were also areas of hyaline degeneration, which varied considerably in extent in the different cases, at times accompanied by leukocytic infiltration and active proliferation of nuclei of the muscle cells (Fig. 1). Small intramuscular hemorrhages were occasionally observed. In no case was there evidence of rupture of the muscle. The gross appearance of the muscular tissue removed for study gave little evidence of the extent of the pathological changes.

Twenty children died from septicaemia or an overwhelming infection. Cultures taken from the blood before death showed organisms in eight cases,—hemolytic streptococcus in seven, and staphylococcus aureus in one. Cultures were obtained from the blood at autopsy in twelve cases; eight showed hemolytic streptococcus and four, staphylococcus aureus. There were four cases diagnosed primarily as septicaemia, three cases of streptococcal tracheitis, three of sinus thrombosis, three of cellulitis, two of peritonitis, and one each of osteomyelitis, mastoiditis, stomatitis, pyelonephritis, and brain abscess. In this group with severe infections, chiefly from streptococci, the muscular tissue showed rather widespread degenerative changes in five cases, less extensive changes in eleven, and no pathology in four. Minute hemorrhages were frequently observed. Fragmentation of muscle fibers and disintegration of the muscular substance in the sarcolemmic sheaths, with vacuoles and what appeared to be granular disintegration, were often found. In only one case, that of a seven-year-old child with a widespread superficial streptococcal infection, was there evidence of a septic focus [24] with early, acute inflammatory infiltration in the fibrous tissue between the muscle bundles. Muscular tissue is apparently far more susceptible to intoxication and circulatory changes than to direct bacterial invasion.

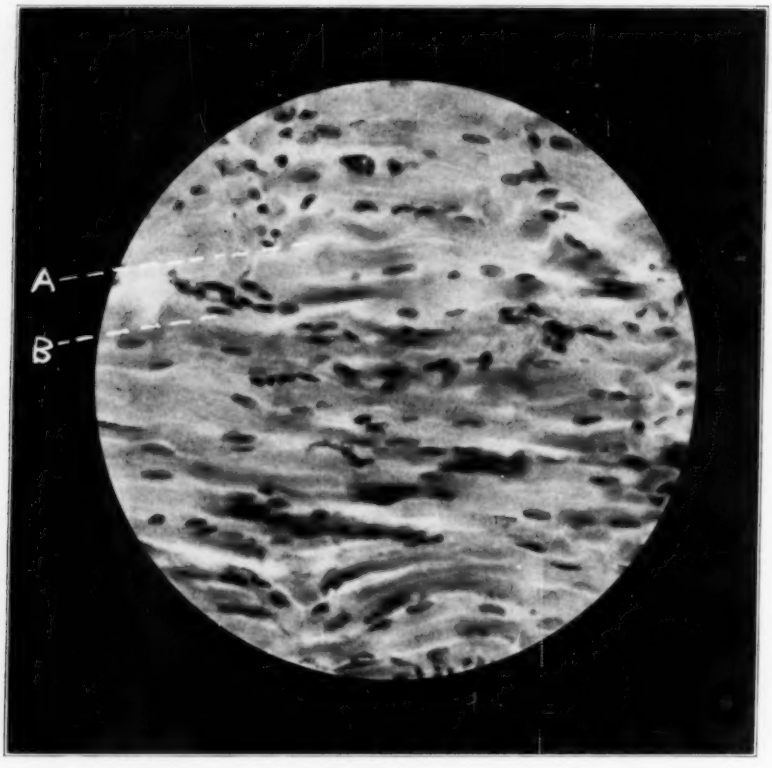

FIG. 1

Photomicrograph of the rectus abdominis muscle (× 350) of a child of three who died from bronchopneumonia. There is extensive hyaline degeneration at *A*. Proliferation of the muscle nuclei about an apparently empty sarcolemmic sheath can be seen at *B*. Phagocytic cells, with darkly staining nuclei, can be observed throughout the section. There are occasional leukocytes. Note the oedema of the remaining muscle fibers and the variability of the staining reaction.

As one would expect, little pathological alteration was found in the muscular tissue of children where death was due to prematurity *per se*. In each of the five cases in which slight pathological changes were found, there was a slight terminal infection, usually of a respiratory nature. Minute hemorrhages between muscle fibers were observed frequently in these cases, some of which were probably the result of birth traumata. In addition to these conditions, localized hyaline degeneration and oedema were the usual findings. No evidence of prematurity of muscular tissue was observed. There is a certain amount of muscular activity during foetal life, and, as far as can be determined, the muscles reach functional maturity during intra-uterine life.

Eleven children in this series died from a nutritional disturbance or a gastro-intestinal infection. Two of these children had bacillary dysentery. There was a complication of tetany in one case, scurvy in another, and

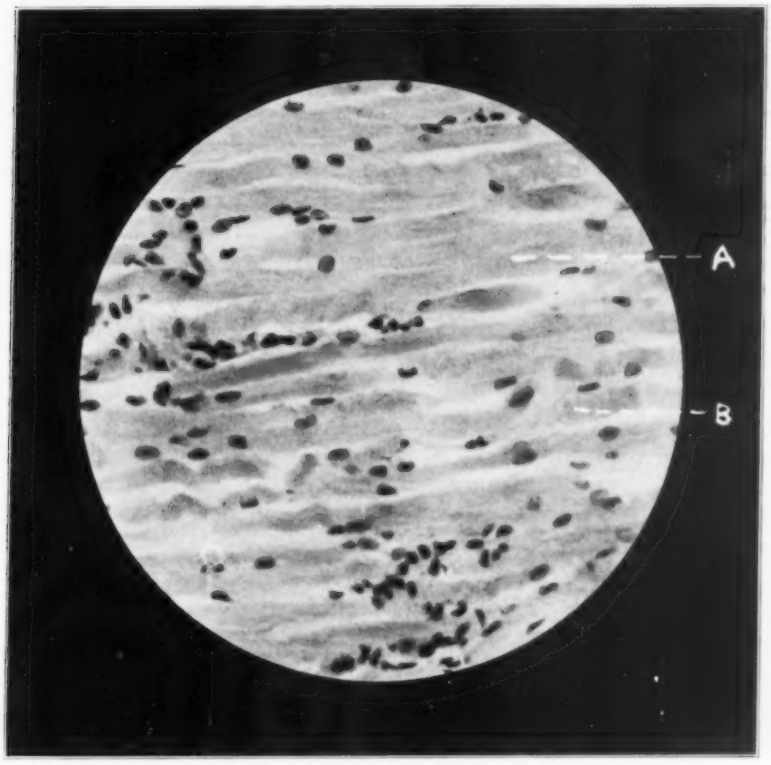

FIG. 2

Photomicrograph of the rectus abdominis muscle (×330) of a child two months old who died from an acute nutritional disturbance. There is slight hyaline degeneration at *A*. Oedema and vacuolation can be seen in the sarcoplasm *B*.

renal rickets in a third. The muscular tissue in seven of these cases showed pathological changes, the most marked of which were found in an eight-year-old child with acute enteritis. The findings differed in no way from those described earlier in this paper (Fig. 2).

In the muscular tissue taken from the six children who died of meningitis, slight hyaline degeneration was observed in three cases. No pathological changes were found in the muscles of four patients who died of tuberculous meningitis.

With the exception of one case, negative findings were also observed in all cases in which death was due to congenital heart disease. In this one case, there were marked oedema of the muscular tissue, minute hemorrhages, and slight hyaline degeneration.

The muscular tissue obtained in five cases of congenital syphilis showed pathological changes. The ages of these children varied between five days and seven months. Hyaline degeneration of the muscles was not observed in any of these cases. The chief pathological finding was an

increase in the perimysial fibrous tissue. There was no evidence of gumma [25].

Noteworthy changes were found in two other patients. One of these, a three-year-old boy, had rhabdomyosarcoma of the urinary bladder, with extensive metastases. The muscles from this patient showed massive infiltration crowding and destroying the muscle cells. There were also many small hemorrhages in the intramuscular septa. The other patient was a boy of ten with tuberculosis of the spine and amyloid disease. There were deposits of amyloid apparently around the muscle cells within the sarcolemmic sheaths. Where the deposits were quite large, complete or partial walling off of the area with fibrous tissue was observed.

DISCUSSION

Many of the pathological changes found in the voluntary muscles of these children were undoubtedly only temporary, and the muscles would have healed entirely if the children had not died. This has been shown by Forbus [26] to be the end result in experimentally produced muscular lesions. The dead muscle tissue is removed by phagocytic cells and new muscle cells are formed by proliferation. Where the damage has been extensive, healing takes place with a certain amount of scar formation. If no regeneration occurs, the muscle is replaced by fibrous tissue.[27] As Brooks [28] has shown, where the circulation of blood and lymph is inadequate, degeneration of a muscle may be followed by complete resorption in seven to twelve days. Bundschuh [29] produced defects in muscles experimentally and observed the various stages of regeneration in which practically normal muscle tissue replaced the defect in ninety-three days. This took place only where the defect was not enlarged during the healing process. Fishback and Fishback [30] produced muscular lesions by various types of injury—chemical, bacterial, and mechanical—and then studied the process of repair. They concluded that, where the injury was slight, as in the case of cloudy swelling, the muscle fibers would probably entirely recover; with greater changes, due to more severe trauma, complete recovery might not occur. If the stroma remained and the sarcolemma was not wholly destroyed, they served as a framework for the remaining muscle nuclei to produce new muscular tissue. Where the damage was extensive, sequestra of muscular tissue might result, as was also reported by Paetzold [31].

If repair of the pathological changes in the muscle occurs promptly, little can be postulated beyond a temporary weakness with slight muscular imbalance. Where repair is delayed or is incomplete, muscular weakness is an inevitable result. Such muscular weakness, whether temporary or permanent, can lead to severe deformity unless the weakened muscles are protected and given proper treatment in order to regain their normal strength and tone. Clinical evidence of such muscular weakness, which may be due in part to disuse and in part to degenerative changes, is seen in the frequent complaint of indefinite pain in the low back and in the legs, particularly during convalescence from a severe illness. It is probably

during this stage, when repair or partial repair is taking place, that these changes in the musculature are of the most importance in the development of scoliosis; and, as clinical evidence attests, a deformity of this type, once started, progresses by well known mechanical laws.

Much has been written on the relation of muscular imbalance to the evolution of scoliosis. Numerous observers have found that scoliosis develops when muscles of the trunk have been cut [32] or have been disturbed functionally on one side of the spine[33]. The importance of weakness in one psoas muscle in the development of scoliosis has been discussed by Krukenberg[34]. Harrenstein [35] in performing autopsies upon children with congenital scoliosis, has observed cases of weakness and faulty development in one of the crura of the diaphragm. Scoliosis, resulting from a defect in the trapezius, has been reported by Schulze-Gocht[36]. The rôle of muscular weakness in producing scoliosis has been fully discussed in recent papers by Carey [37] and by Hauser[38]. Muscular weakness, as a factor in the development of scoliosis, was recognized in 1896 by Brackett [39] who measured the relative strength of the muscles on the two sides of the spine in sixteen cases.

Clinical evidence, as well as the history of many patients with scoliosis, leads us to believe that such unrecognized muscular weakness often acts as the cause of scoliosis. Unfortunately, the child with scoliosis usually comes for treatment only after extensive spinal deformity has occurred, and attempts to determine previous muscular weakness are difficult and uncertain. The number of cases of scoliosis in which the etiology is unknown varies in different clinics, but is admitted by all to be large. How many cases may be the result of muscular weakness, due to pathological changes following disease, we can only conjecture. When the possibility of disturbances in muscle function, following illness in childhood, is recognized and watched for, a step in the prevention of such scoliosis will have been attained. Where weakness of the musculature supporting the spine is found, adequate rest and the support of the spinal column are our most effective therapeutic measures[40].

CONCLUSIONS

In a study of the musculature supporting the spinal column, pathological changes in the muscular tissue were found at autopsy in sixty-three of 100 children who died of the usual diseases of childhood. In most of these cases, complete healing would probably have occurred if the children had recovered. Where complete healing of these pathological changes does not occur, or occurs slowly, the resultant muscular weakness may be the cause of scoliosis.

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ACETABULAR DECOMPENSATION *

BY EDWARD K. CRAVENER, M.D., SCHENECTADY, NEW YORK

The object of this paper is to present a cause of hip-joint pain based upon an infrequent aberrancy of acetabular development. The pure mechanics of this disorder will be outlined.

Development of the Acetabulum:

To clarify our theory, a brief review of the development of the hip socket is necessary. In the new-born child, the acetabulum is composed of two equal parts,—the iliac portion and the ischiopubic portion.[1] As growth proceeds normally the acetabulum comes to be composed of three parts ischium (ischium and pubis) and two parts ilium. In short, the lower portion grows one-third faster than does the upper part (Fig. 5).

Variations in growth rate can produce acetabula of different shapes and sizes. Should the iliac portion lag behind in this relationship, the socket will be shallow. Conversely, if the iliac portion overgrows, the acetabulum will be large and its upper portion oblique. In either case, there will be an inadequate upper margin.

Pathological Anatomy:

The result of this disorder is an insecure hip, occasioned by faulty development.

If the acetabulum is large and oblique, part of the weight ordinarily borne by the bone and cartilage of the joint will necessarily be carried on the superior supporting ligaments of the hip. If the acetabulum is small, the result will be the same,—*i.e.*, weight will be borne on structures ill adapted for this purpose. These conditions are shown graphically in Figures 1, 2, 3, and 4. As explained in the captions, engineering principles demonstrate that immense strains are borne on the relatively inadequate hip ligament. This results in bone and calcium deposition in the affected ligaments, which is sufficient evidence of intolerable chronic strain.

Symptoms:

The four cases seen by the author have presented the following symptoms: First, there was an early period with vague, non-radiating pains, localized deep in the hip joint, made worse by exertion and bettered by rest. The pain was usually worse on adduction of the leg; there was no history of real limitation of hip motion. Second, there followed a period with almost constant deep hip pain, made worse by the slightest motion

* Presented by title at the Conference on Rheumatic Diseases, held under the sponsorship of the American Committee for the Control of Rheumatism, New Orleans, Louisiana, May 9, 1932.

HYPOTHETICAL HIPS WITH PARALLELOGRAMS OF FORCE TO ILLUSTRATE FORCES EXERTED ON THE BONY STRUCTURES AND LIGAMENTS

FIG. 1

Normal stable hip which bears only weight of body in any position.

LOAD ON FEMORAL HEAD = 169 LBS
LINE OF ACTION OF BODY WGT
150 LBS
LOAD ON LIGAMENT = 56 LBS
PARALLELOGRAM OF FORCES OF 50% ACETABULUM

FIG. 2

Fifty per cent. acetabulum. This hip is stable in neutral. In twenty degrees' adduction 56 pounds are borne by the ligaments and 169 pounds are borne on the bony structures.

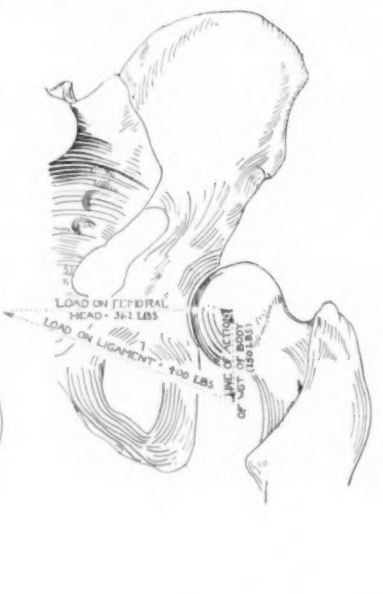
LOAD ON FEMORAL HEAD = 362 LBS
LOAD ON LIGAMENT = 400 LBS
LINE OF ACTION OF WGT OF BODY (150 LBS)
PARALLELOGRAM OF FORCES OF 40% ACETABULUM

FIG. 3

Forty per cent. acetabulum in neutral. Pull of 400 pounds is put on the femoral ligaments. Weight of 362 pounds is borne directly on the acetabulum.

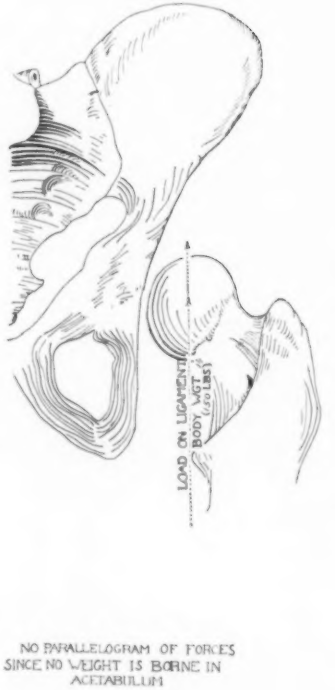

FIG. 4

Complete dislocation of the hip without an acetabulum. Here the weight of the body, and no more, is borne by ligaments alone.

and only moderately benefited by rest. At this late period in two of the cases the patients complained of pain over the entire leg and thigh, which was not limited to any segmental zone. Two of the patients resorted to crutches in attempts to gain relief. One patient was referred to a tuberculosis sanitarium for treatment.

All four patients, singularly enough all women, gave histories of

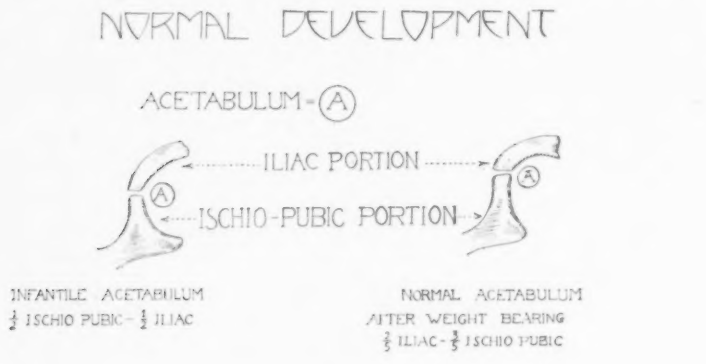

FIG. 5

Upper: To demonstrate growth in properly developed acetabulum. Here, after weight-bearing, the hip socket is composed of two-fifths iliac and three-fifths ischiopubic portions.

Lower: Figure on left shows results of undergrowth of ischiopubic portion. The resultant acetabulum is large and without effective marginal lip.

Right portion of plate shows results of undergrowth of iliac portion. This acetabulum is small and inadequate for a normal femoral head.

sudden gains in weight and reports of slight traumata which preceded their early attacks.

In all four cases, anteroposterior roentgenograms showed either a small acetabulum covering less than half of the femoral head or a very large acetabulum with practically no superior acetabular lip. All of the cases showed calcification in the superior portion of the supporting ligaments of the hip joints.

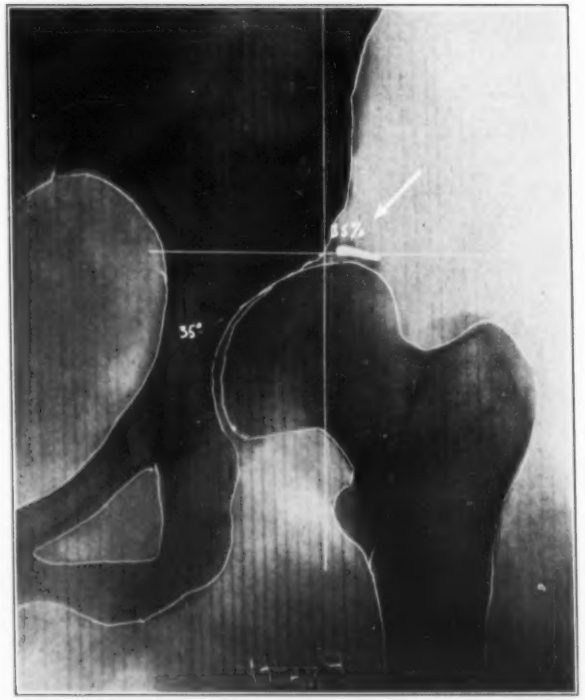

FIG. 6

Case 1. (M. P.) Roentgenogram before operation.

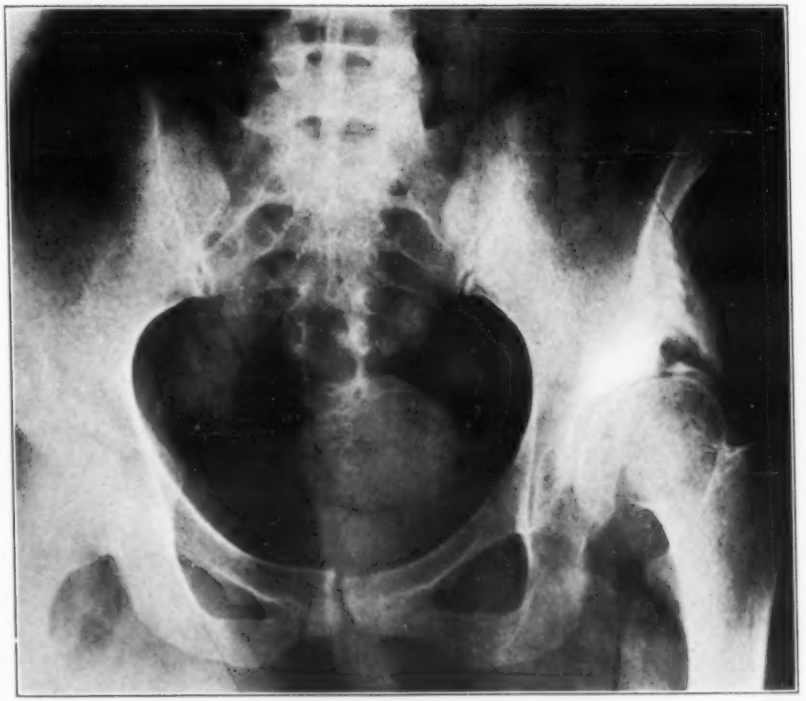

FIG. 7

Case 1. (M. P.) Roentgenogram after operation.

Diagnosis:

In this very short series, diagnosis has been made on a history of hip-joint pain with roentgenographic evidence of an acetabulum, either small and inadequate, or large and oblique.

Differential Diagnosis:

These cases could be considered hypertrophic arthritis in the sense that hypertrophic arthritis is a reaction to intolerable injury. However, since congenital deformities are here present and demonstrable, the writer feels that this is a separate clinical entity.*

Treatment:

This whole disease is evidently based on inadequate support of the body at the hip joint. Therefore, an acetabular shelf, properly placed to supply this deficiency, is indicated. In the three cases (four hips) operated upon, this has been done with symptomatic relief.

Nomenclature:

This condition is called "acetabular decompensation", by the writer, since these hips act exactly as do some congenital disorders of the heart, functioning perfectly until a load or trauma greater than their tolerance forces them into a decompensation.

FIG. 8

Case 2. (A. C.) Roentgenogram before operation.

* Since this concept was developed, an illuminating article by the late Lawrie B. Morrison has appeared in *The American Journal of Roentgenology and Radium Therapy*, (A Study of the Hip Joint from the Standpoint of the Roentgenologist, XXVIII, 484, October 1932) on the possible presence of a separate epiphysis for the acetabular margin. If such an epiphysis exists, it is feasible to regard a percentage of these cases as due to a failure of this epiphysis to unite or develop. The end result is the same; the resultant acetabulum is either too short and small, or presents a sheer incompatible with stability.

CASE REPORTS

CASE 1. M. P. (Hospital No. 99248), female, married, aged twenty-two, presented herself in June 1931, complaining of pain in the left hip dating back to a slight injury two years before. The pain was practically intolerable when attempts at ambulation were made. In fact, certain consultants suspected synovial tuberculosis. The patient was perfectly comfortable in a non-weight-bearing position; there was no muscle spasm about the hip. There was slight increase in abduction with slight diminution of adduction; passive rotation of the hip caused pain in the extreme. A pre-operative roentgenogram is presented in Figure 6.

On July 29, 1931, a shelf was built over the left hip. After the usual period of necessary rest, weight-bearing was begun. Ten months after operation the patient walked without difficulty or limp. There were no residual effects except a slight limitation of abduction. A postoperative roentgenogram is shown in Figure 7.

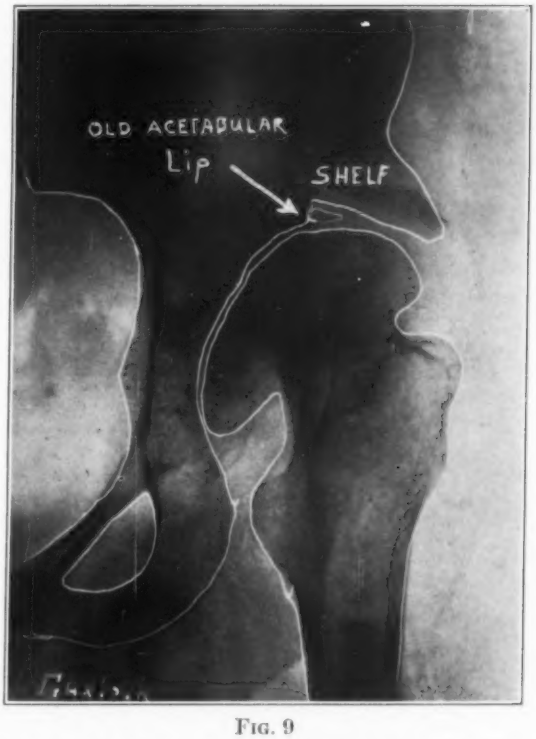

FIG. 9

Case 4. (Dr. E. M. G.) Roentgenogram taken six months after operation. Bony structures outlined with ink for clarity.

Inquiry two years after operation revealed that patient dances two or three times weekly. All motions of the hip are present save the extremes of abduction. There is no pain.

CASE 2. A. C. (Hospital No. 4103), female, single, aged thirty-three, entered the hospital January 14, 1930, complaining of pain in both hips, worse after exertion and bettered by rest. This disability was dated by the patient to a minor fall about three years previously. The disability had become so marked as to incapacitate the patient. There was no peculiarity of gait; no Trendelenburg sign. There was some limitation of motion in the extremes by reason of pain. Physical examination was otherwise negative, except for the presence of several carious teeth. A roentgenogram taken at this time is shown in Figure 8. In February 1930 a shelf was built over the left hip, and two weeks later the same operation was done on the right. Three years after operation the patient walked without difficulty and without pain.

CASE 3. M. S. (Office No. 125–1), female, married, aged sixty-two, complained of pain in the right hip joint of three years' duration. An increase of twenty pounds in weight had occurred about three years previously. Simultaneously pain developed in the right hip, noticeable after exertion. This had gradually increased to total disability.

Roentgenographic examination showed a fifty per cent. acetabulum on the right with hypertrophic change in the iliofemoral ligaments. The motions of the right hip were painful and decreased in the extremes. The left hip was normal in structure.

Operation was refused. The patient was confined to bed for two weeks; the pain completely disappeared, but recurred in full intensity when weight-bearing was resumed.

This patient has been lost trace of and the case is presented only as an example of this disorder. It is interesting to note the long period of latency of this disease. Here, the absence of other hypertrophic changes and the sudden gain in weight would indicate that this is typically a decompensated hip joint.

CASE 4. Dr. E. M. G. (Hospital No. 8005), female, single, aged fifty, made a complaint of pain in the left hip of seven years' duration. Early in the disorder (during the first two or three years) pain was present only after exertion. In the last four years pain had been almost constant. Relief was found late at night after rest. There was no radiation of pain.

Physical examination was negative except for a permanent adduction of twenty degrees in the left leg. All motions were present except active and passive abduction. The extremes of motion gave pain. The right hip was completely dislocated and was painless. There was a real shortening of two and one-half inches on the right. The back showed a structural left dorsal, right lumbar curve which produced no symptoms.

In October 1932, after manipulation to reduce the adduction, a shelf was built over the left hip. Nine weeks later the patient returned to her occupation with no hip discomfort.

Follow-up, made ten months after operation, showed slight limitation of passive and active abduction. There was no pain in the hip region.

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MULTIPLE FRACTURES ASSOCIATED WITH BLUE SCLERA

BY EMANUEL B. KAPLAN, M.D., NEW YORK, N. Y.

The nature of multiple fractures associated with blue sclera is obscure. This affliction has been studied by many investigators, and the roentgenographic appearance, pathology, heredity, biochemistry, clinical course, and treatment have been reported in almost every language. Although this condition is known everywhere, many points are awaiting further elucidation.

The purpose of this paper is to add another method of treatment to the long list of therapeutic measures and to investigate the character of the blue discoloration of the eyeball.

In the family of one of the patients observed, it was found that in all the female members the fractures ceased after the normal onset of the menstrual cycle. To verify this observation, a number of cases were studied from the available literature. This study showed that, in a large proportion of females afflicted with multiple fractures, the establishment of a normal menstrual cycle coincided with cessation of the fractures.

It was considered then that, until maturity takes place, the administration of the ovarian hormone to little girls suffering with multiple fractures might bring relief. With this in view, injections of a soluble extract of ovarian substance were given once a week over a certain period. Unfortunately, the treatment could not be continued because one family moved to a different town and the other patient, after a series of twelve injections, refused treatment on account of pain. During the period of injections, no fractures occurred and the patients felt very much better. The frequency of administration was chosen at random. The necessity of the injection method has been felt to be a serious obstacle, because the little patients usually object to repeated injections. The availability of a hormone which could be administered effectively by mouth would facilitate the management of these cases.

The etiology of idiopathic multiple fractures is not known. There might be several distinct types requiring different therapeutic measures. Even the group isolated by Key as a hereditary hypoplasia of the mesenchyma may not be a uniform group. The existence of a definite type, characterized by cessation of fractures in girls after puberty, may be suspected. In cases of this type, the administration of the ovarian hormone may be tried.

In our cases most of the findings of the other authors were confirmed. The biochemistry, heredity, and clinical course were identical to those in the many cases previously reported. One of our patients developed an acute otitis media. The leukocytic response was similar to that of a normal person,—an early high polymorphonuclear leukocytosis, coincident with the onset of infection, subsided gradually with the infection.

In order to investigate the factors responsible for the blue sclera, it was decided to instil a solution of eserine into the eyes of the patients in one series of observations and a solution of atropine in another series. It was thought that, if the blue discoloration were due to increased transparency, the contraction of or dilatation of the vessels of the uvea and tunica choroidea would influence the intensity of the discoloration. The two patients, who were under observation, and the mother of one of them, who also had intense blue sclera, were studied for this purpose. No changes in the discoloration of the sclera were found in either series. The reactions of the pupils were normal. In contrast to these observations, it was found on several occasions that the intensity of the bluish discoloration of the sclera varied without apparent reason.

The results obtained after the instillation of the above mentioned substances were unexpected, as it was believed that, in the case of thinness of the sclera, the action of atropine or eserine on the eye vessels would result in some change in the color of the sclera. Apparently the contention that the color of the sclera is due to an abnormal transparency needs further confirmation.

The following cases were studied at the Hospital for Joint Diseases on the Service of Dr. Harry Finkelstein.

Case 1. B. G. (No. 38489), a white female, aged six years, was admitted to the Hospital on June 8, 1932, suffering from a fracture of the middle third of the left femur, with posterior and medial angulation.

Past History: Patient was normal at birth, and weighed under six pounds. She was nursed for eleven months and was given viosterol and cod liver oil. At the age of thirteen months, she had a fracture of the left arm, which healed well. At nineteen months, the right leg was accidentally broken. When two and one-half years old, she fell and broke her right arm. All of these fractures healed with more or less deformity. At the age of three years and eight months, she broke her left femur, and suffered a second fracture of the same femur about six months previous to her admission to the Hospital. She had never been seriously ill; dentition was normal. Her sclera were always blue.

Family History: The mother has blue sclera, but has had only one known fracture. The patient's sister, who is at present fifteen years old, has a typical history of multiple fractures. The patient's aunt on the maternal side has blue sclera. She has had no known fractures, although she has suffered from frequent sprains and has bow legs. There were five maternal uncles, four of whom died in infancy and about whom nothing is known; the one living has white sclera and no fractures. The maternal grandmother had blue sclera, and many fractures, and was crippled all her life. The maternal great grandmother had many fractures and was also crippled throughout life; it is not known whether or not she had blue sclera. The mother, the maternal aunt, the grandmother, and the great grandmother were all more or less deaf. The grandmother had two sons,—one was well and the other had typical blue sclera, with multiple fractures, and he was also deaf.

Physical Examination: Examination showed the patient to be undernourished, but very intelligent. Her sclera were blue. She showed multiple deformities involving the upper and lower extremities, a slight kyphosis with a prominence of the lower ribs, an angulation and a genu valgum of the left leg. There was a recent fracture of the middle of the left femur with a posterior angulation. The patient also had an acute right otitis media with a profuse discharge of pus. The muscles showed a normal reaction to electrical excitation. She had a definite hypotonia. The deep reflexes were normal.

Laboratory Studies: Blood examinations on three occasions showed:

Red blood cells	4,480,000	3,358,000	4,200,000
Hemoglobin	65 per cent.	70 per cent.	75 per cent.
White blood cells	14,830	8,300	6,400
Lymphocytes	28 per cent.	36 per cent.	41 per cent.

	Milligrams per 100 cubic centimeters of blood		
Sugar		88.0	
Calcium		10.5	
Phosphorus	5.8	4.7	
Urea nitrogen		472.0	

The Mantoux test was negative. The urine was negative; no Bence-Jones protein was present. Repeated examinations of feces were negative for ova and parasites. Blood Wassermann was negative.

The following is an abstract of an x-ray study made by Dr. M. Pomeranz of the Hospital for Joint Diseases:

The skull shows extreme thinning of all the bones, striae are present. Examination of the spine discloses a moderate kyphosis with a distinct loss in the cancellous detail of all the vertebrae, associated with very pronounced biconcave compressions of most of the dorsal and practically all of the lumbar segments. In the dorsal region, the bodies are reduced to small "wafer-like" densities. In the third, fourth, and fifth lumbar vertebrae, there appeared to be incomplete fractures between the bodies and laminae, as shown in the posterior views. The ribs are extremely atrophic and the trabeculae cannot be distinguished. The pelvis discloses an extreme atrophy of the bones.

The bones of the upper extremities are distinctly underdeveloped in the width of the humeri. The capital epiphysis of the left humerus is atrophic. There is a moderate eccentric atrophy in the shaft with distinct thinning of the cortex, which appears to be somewhat granular externally. In the distal third the trabeculation is extremely coarse. The right humerus shows an identical process, but, at the junction of the middle of the distal third of the shaft, a slight deformity suggests an old fracture at this level. The bones of the right forearm show a distinct underdevelopment of the shafts with eccentric atrophy in the proximal two-thirds. In the distal half the bone is so thinned out that it almost merges with the soft-tissue density. The hands disclose changes which appear to be most marked in the metacarpal bones. The cortices appear to be granular in spots. There are no periosteal changes in the phalanges.

The examination of the bones of the lower extremities shows similar changes. The left femur shows an external angular deformity at the junction of the middle and distal thirds at the site of an old fracture. Approximately one and one-half inches above the epiphyseal line is noticed a complete oblique fracture of the shaft, with a slight callus formation. The shaft proper shows extreme coarseness in trabeculation, with areas in the medulla extremely suggestive of cyst formation. The distal third of the right femur has the appearance of extremely large multiple cysts. There is no evidence of fracture at this level. The bones of the legs show very marked eccentric atrophy in the proximal metaphyses of the tibiae. There is a very distinct granular disintegration of the cortices of the tibiae in the lower metaphyses. In the proximal and distal thirds of the shaft there are evidences of old fractures that healed without deformity. The cortices of most of the metatarsal bones are reduced to "egg-shell" thinness.

In all the bones there is a distinct acceleration in the appearance of the centers of ossification and in the development of the epiphyses.

The extreme granular disintegration, particularly in the tibiae, resembles strikingly the changes which have been described in parathyroid disease.

Adhesive plaster traction was applied and the patient made an uneventful recovery. She was discharged on July 13, 1932, with good union of the fragments.

After discharge from the Hospital, the patient was given injections of one cubic centimeter of soluble extract of ovarian substance once a week for ten weeks. While

receiving the injections, she felt very much better and had no fractures. The injections, however, could not be continued on account of the patient's moving to a different city.

On July 20, 1932, two drops of a 1 to 100 solution of atropine were instilled into the left eye of the patient and the eye was observed at frequent intervals for forty-eight hours. The usual dilatation of the pupil developed, but there was no change in the character and intensity of the blue discoloration of the sclera. Three days later two drops of a 1 to 100 solution of eserine were instilled into the left eye and the patient was examined at frequent intervals for forty-eight hours. No changes were noticed in the color of the sclera.

The sister, mother, and maternal aunt were also examined.

The sister had blue sclera, and a history of multiple fractures beginning at the age of thirteen months. She had her last fracture at eleven years. Her menstruation started when she was twelve years old. She is fifteen years old at present and has had no more fractures. She has an angular deformity of the right elbow and scoliosis of the spine. She is small in stature, but feels well and strong, and is very intelligent. The examination of her blood did not disclose anything abnormal; her blood pressure was normal and the Wassermann reaction was negative.

The mother also has blue sclera. She is small, slightly deaf, and has no visible deformities. Her blood and blood pressure are normal. An examination of the eye, by the instillation of atropine and eserine, similar to that made on her daughter, was done and the results regarding the change of color of the sclera were absolutely negative.

The maternal aunt, who is thirty-five years old, has intense blue sclera, but does not know of any fractures and is not deaf. She is small of stature and has very pronounced bilateral genu varum deformities. Her blood and blood pressure are normal.

Case 2. J. M. (No. 2178), a white female, aged eight years, was admitted to the Hospital in April 1932.

Past History: The patient was delivered with forceps and weighed eight pounds at birth. She developed normally until the age of three and one-half months, when she developed attacks of cyanosis, most of which occurred while she was sleeping. Several physicians thought of a thymus affliction and x-ray treatments were administered. When the baby was six months old, the thymus was pronounced normal. Dentition was normal. The patient was weaned at seven months and subsequently had a well balanced, medically supervised diet. She was always heavy, weighing thirty-seven pounds when seventeen months old. She started to walk at fifteen months. Her first known fracture—a fracture of the left ulna—occurred when she was three years old. At that time, the nature of her affliction was not recognized. Shortly after this fracture healed, she sustained a fracture of the left leg. Between the ages of three and four years, she had altogether six fractures and, within the past year, has had two more fractures. The mother emphasizes the fact that the patient never has had ecchymosis or extensive swelling at the time the fractures have occurred. Multiple examinations of the blood did not reveal anything but a normal picture.

Family History: Both parents seem to be normal. On very close examination, the mother showed a faintly bluish discoloration of the sclera, which she had never noticed. She had always been well and had never had any fractures. No member of the mother's family has ever had any fractures, and no discoloration of the sclera has ever been noticed.

Physical Examination: Examination showed the patient to be well nourished and of normal intelligence. The patient presented the characteristic syndrome of fragilitas ossium with blue sclera. She had a peculiarly shaped head; her neck seemed to be short and the trunk was disproportionately shorter than the upper and lower extremities, giving her an ape-like appearance. She had multiple deformities of the arms and lower extremities, the most noticeable of which were: reversed carrying angle of the left elbow, bilateral genu valgum, and a very marked bilateral planovalgus deformity, more pronounced on the left side. Her reflexes were normal. Her blood histology and chemistry were normal.

To establish the influence of atropine and eserine on the patient's sclera, two series of

observations were made on her left eye. A 1 to 100 solution of eserine was injected into the left eye. Frequent examinations were made within forty-eight hours and no change in the discoloration of the sclera was found. The instillation of a 1 to 100 solution of atropine into the left eye, a few days later, had no visible effect on the sclera.

The patient received a series of twelve injections of the ovarian extract subcutaneously. While receiving the injections, she felt better and had no fractures. However, on November 30, 1932, four months after the last injection, she sustained an oblique fracture of the distal end of the right radius with no displacement. The fracture was treated by immobilization and healed in a very short time. On January 13, 1933, the patient developed a fracture of the distal third of the left tibia. On April 20, 1933, she sustained another fracture of the upper third of the left tibia and the upper extremity of the left fibula. All of these fractures occurred four months after she had received her last injection. This last fracture was treated at the Vanderbilt Clinic, New York City. A short report from the Vanderbilt Clinic showed a normal blood chemistry and an x-ray examination of her skeleton showed the usual changes found in brittle bones.

There are a few salient points in the observation of the cases described which, with the data gathered from the literature, suggest that brittle bones, with blue sclera of the hereditary or spontaneous type, may be due to some endocrine disturbance. The therapeutic response to the ovarian-gland extract in our series of cases, the favorable results obtained by the thymus treatment in the hands of Ryan, the peculiar x-ray appearance of the bones, not unlike that found in parathyroid disease, the early appearance of centers of ossification, and, in our Case 2, the early discovery by competent clinicians of a thymus affliction, seem to favor an endocrine disturbance as a possible explanation of brittle bones.

The hereditary form of brittle bones with blue sclera is at present classified as a hereditary hypoplasia of the mesenchyma. There are a few factors, however, which do not seem to be in full agreement with this generalization.

The formation of callus in fragilitas ossium seems to be normal, or even more pronounced than in a normal case. Although the blood vessels are considered to be brittle, yet, in most of the cases of fragilitas ossium, no ecchymoses are observed. The chemical constitution of the bones, as reported by several observers, is normal. The late appearance of deafness, which is explained by otosclerosis and abnormal calcification of the labyrinthine system, would probably speak against hypoplasia, and the early appearance of centers of ossification would not seem to be an expression of hypoplasia of the mesenchyma.

The nature of brittle bones associated with blue sclera requires further study, which may show whether or not this affliction is really of an endocrine character. In the meantime, it may be advisable to administer some form of ovarian hormone to girls afflicted with this disease before the onset of their normal menstrual cycle.

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HEMATOGENOUS TUBERCULOSIS OF SKELETAL MUSCLE

Report of a Case with Involvement of the Gastrocnemius Muscle

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As far as we can determine, the following is the second case of hematogenous (so called primary) tuberculosis of skeletal muscle to appear in the American literature. In addition to its rarity, our case presents these distinctive features:

1. The lesion reached an exceptional size.
2. Clinical observation extended from inception of the disease over a period of two years.
3. Specific etiology was completely proved by pathological and bacteriological studies.
4. The treatment of choice accomplished good symptomatic and functional results.
5. Due to prior history of injury suffered by the patient while at work, medicolegal problems, pertinent to industrial compensation, came up for solution.

REPORT OF CASE

R.S., male, aged twenty years, white, American aircraft mechanic, was admitted on the Service of Dr. Robert P. Dobbie, December 19, 1930, complaining of a swelling in the calf of the left leg, of four weeks' duration. He had always been in good health.

The family history was negative.

In February 1930, while at work, the patient stumbled over an air hose and fell, striking his left knee on a block. Soon after the knee became swollen. For nine weeks treatment consisted of baking and the application of ointments; no splints were used. The patient continued at his work. In April 1930, he was seen by Dr. Dobbie who made a diagnosis of fracture of the outer table of the left patella, which was confirmed by roentgenographic examination. Because of atrophy of the quadriceps muscles, exercise and massage were recommended.

On December 18, 1930 the patient was seen by one of us (W. W. P.), because of a large swelling in the left calf which had first appeared as a nodule three weeks previously and had then grown progressively larger. Pain was present in the region of swelling and radiated downward to the ankle. There was also a constant "tight feeling" in the calf muscles. Locomotion was not impaired. The patient's weight had remained unchanged. Functional inquiry, except for chief complaints, was negative.

Physical examination at the hospital showed the patient to be well developed and well nourished. The chest was clear. Inguinal nodes were palpable. The left thigh muscles showed distinct atrophy. The knee joint was not swollen or painful; mobility was good. The patella, which was free, presented a longitudinal groove in its surface. In the left calf, posteriorly, situated in the upper third of the gastrocnemius muscle, was a mass the size of a goose's egg, apparently well encapsulated, movable, and cystic, but

not fluctuant. The overlying skin was intact, smooth, and normal in temperature. There was no oedema of the left ankle; the veins were not dilated. Reflexes were present and active.

The temperature was 98 to 99 degrees; pulse, 80 to 90; respiration, 20.

Laboratory findings showed: glucose, 111 milligrams per 100 cubic centimeters of blood; urea nitrogen, 9.9 milligrams per 100 cubic centimeters of blood; white blood cells, 9,800 per cubic millimeter; a few scattered white cells were found in the urine; the Kolmer and Kahn tests were negative.

Roentgenograms of the spine, pelvis, femur, left knee joint, tibia, fibula, and ankle revealed no remarkable changes in the bone, periosteum, or joints except for a scar about the left patella,—the result of an old fracture.

During his four days' stay in the hospital, the patient made no special complaints. No oedema of the left leg was noted. No surgical intervention or aspiration was made. The diagnosis at discharge was "cystic" tumor in the left gastrocnemius muscle, nature undetermined.

Shortly after the patient was discharged from the hospital, the mass in the left leg had almost disappeared. The patient returned to work and was not seen again until December 1932. At this time, he gave the history that during the previous two months the swelling had reappeared and had grown rapidly larger, finally reaching such a size as to impede locomotion. Pain was not prominent. Several weeks before this visit, the patient had noticed that the "nodes" in the left groin had increased in size. The patient had lost six pounds in weight.

Upon admission to the hospital in January 1933, physical examination showed flabbiness of the muscles of the left thigh, with atrophy. The left foreleg could be extended fully, but motion was limited in extreme flexion. In the posterior medial aspect of the left calf, situated in the upper third of the gastrocnemius muscle, was an oval mass, the size of a small grapefruit, irregular in contour, but apparently well encapsulated, movable, tense, with firm and soft areas, and not tender to pressure. There was no attachment to skin or bone; no heat or redness. The left calf measured thirty-eight and five-tenths centimeters in circumference; the right calf, thirty-two and five-tenths centimeters.

FIG. 1
Posterior view of lesion in left calf.

FIG. 2
Anterolateral view of lesion.

The lymph nodes in the right groin were just palpable. In the left groin were palpated two tense nodes, the size of a walnut,—one laterally, below the inguinal ligament; and the other, medially, over the pubis. The temperature was 97 to 99 degrees; pulse, 80 to 90; respiration, 20.

Laboratory studies showed: red blood cells 4,400,000; hemoglobin (Tallqvist) 80 per cent.; white blood cells 8,600; polymorphonuclears 64 per cent.; lymphocytes 30 per cent.; monocytes 6 per cent. The tuberculin test was positive; the urine was negative for Bence-Jones protein.

Roentgenographic examination showed the following: *chest*—apices fairly clear, diaphragm regular, hilus shadows of moderate size; *left knee*—patella irregular in outline with exostoses around edges, joint clear, large shadow in the muscles of the calf. The clinical impression was sarcoma or tuberculosis of the muscles of the calf.

FIG. 3

Roentgenogram showing shadow in soft tissue, old fracture of patella, and normal bone and joint.

The subsequent hospital progress may be outlined chronologically as follows:

January 11, 1933: Left inguinal node was excised. Pathological report: typical fungoid tuberculosis, with large confluent epithelioid tubercles especially in cortex of node.

January 21, 1933: The wound in the left groin was healed.

January 30, 1933: Under avertin-nitrous oxide anaesthesia, an incision was made along the inner aspect of the "tumor" mass. The soleus muscle was split. The mass lay within the continuity of the gastrocnemius muscle (which was split) and possessed a thick wall, enclosing a large amount of curiously fixed gelatinoid material. The thick capsule was intact. The mass had no connection with the tibia or inner hamstring tendons. The wound was closed loosely with two small drainage wicks.

Pathological report: Sections from the wall showed typical tuberculosis, with epithelioid and epithelioid-giant-cell tubercles. An isolated structure, resembling tendon, was also present. Bacterial stains revealed no tubercle bacilli.

Bacteriological report: Culture of fresh tissue, ground and digested with sulphuric acid, was negative for tuberculosis. A guinea-pig, injected with digested tissue, gave a positive culture for tuberculosis within eight weeks. Tubercle bacilli were found in the smears and histological sections; culture was positive in twenty-five days. A rabbit,

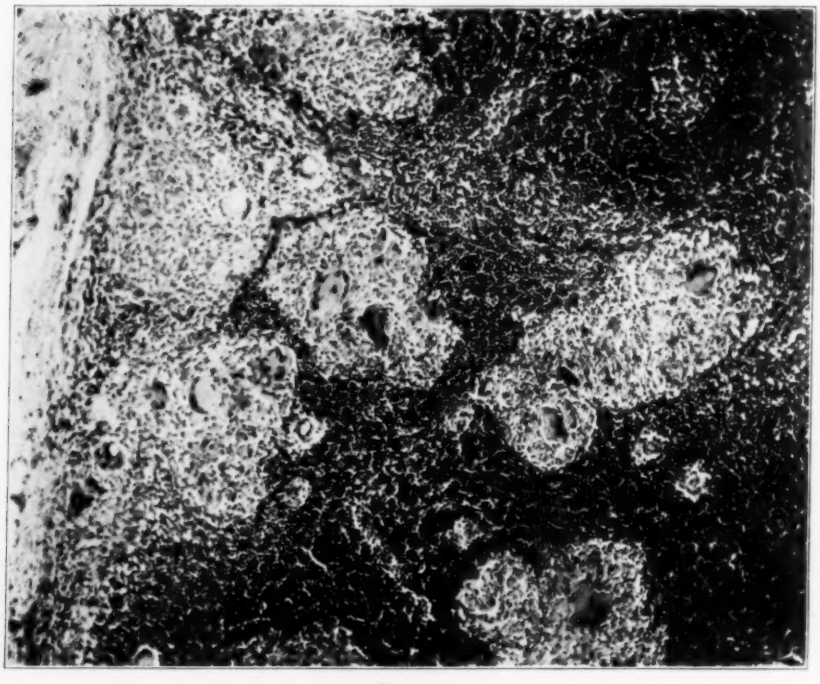

FIG. 4

Confluent tubercles in cortex of lymph node.

inoculated on January 30, 1933 with ground tissue, was killed on March 25, 1933, and the culture was negative for tuberculosis.

February 20, 1933: There was no drainage; the wound was healed; there was no pain or oedema. Two weeks later, roentgen-ray therapy was begun.

Seven months after discharge from the hospital, the patient had no complaints. There was no recurrence of swelling. The left knee was not swollen. Flexion was not impaired. Extension showed limitation of ten degrees.

COMMENT

Chronic tuberculosis of skeletal muscle is of uncommon occurrence. Culotta[1] in 2,224 autopsies on tuberculous patients discovered only four instances of this disease. Upon an etiological basis, two forms are recognized. In the first (secondary) type, the tuberculous process spreads into the muscle by direct extension from a neighboring structure—*e.g.*, bone, joint, tendon, lymph node, pleura, skin, and mucous membrane[2]. In the second type—which has been variously designated as hematogenous, embolic, metastatic, isolated, and primary tuberculosis of muscle, and which is exceptionally rare—infection is carried into the muscle through the blood stream from a tuberculous focus elsewhere in the body. This condition is not dependent upon acute miliary tuberculosis. The term "primary" can be accurately employed here merely in the sense that, in some instances, the muscle offers either the only demonstrable tuberculous lesion in the body or the most prominent tuberculous lesion.

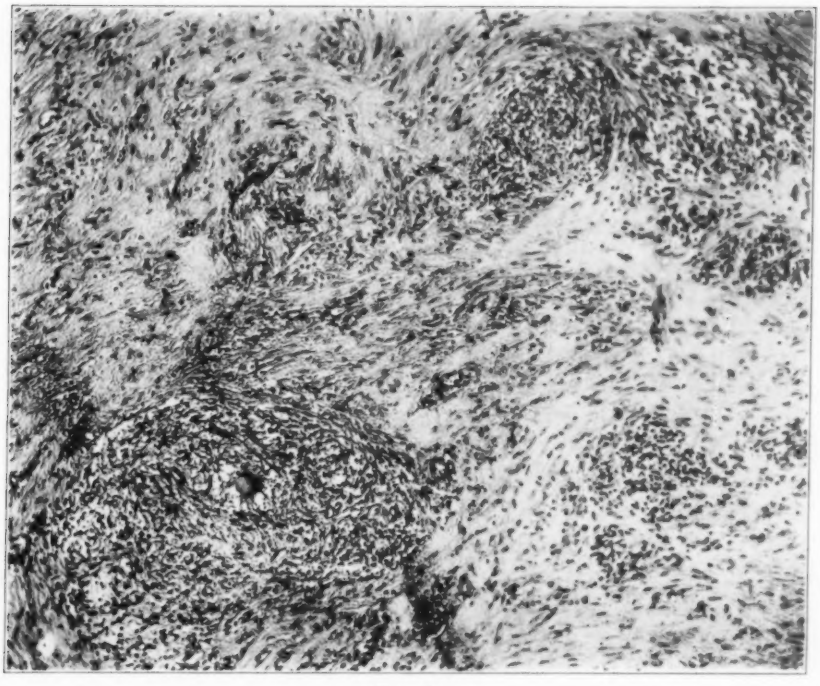

FIG. 5

Giant-cell and epithelioid-cell tubercles in wall of excised specimen.

Habermaas[3] and Müller[4] are credited with describing in 1886 the first two cases of hematogenous tuberculosis of skeletal muscle. Since then, about fifty-five authentic instances have been recorded chiefly by German, French, and Italian authors[5]. The only case to appear in the American literature up to the present is that of Rugh[6] in 1913. Clairmont, Winterstein, and Dimtza[5] published the last general review on the subject.

From chemical, anatomical, and immunological points of view, several attempts have been made to explain the infrequent incidence of hematogenous tuberculous infection in skeletal muscle. Tria[7] believed that the production of lactic acid prevented infection. Culotta[1], on the other hand, discounted this view and suggested the lack of reticulo-endothelial tissue in muscle as a protective factor. Clairmont, Winterstein, and Dimtza[5] stressed the lack of lymphatic tissue and, also, with Zahnert[8], the abundant blood supply. Von Baumgarten[9] attributed the comparative immunity of muscle to its highly differentiated state. Tubby[10] stated that this immunity "may possibly be due to the presence of antitoxin bodies". The inadequacies of the foregoing anatomical explanations are brought out by the fact that in organs like the liver and the kidney, perhaps equally as highly differentiated and as well vascularized as muscle, and with a similar dearth of lymphatic tissue, hematogenous tuberculous infection often develops.

In 1902 Saltykow[11] studied the pathogenesis of hematogenous tuberculosis of muscle by injecting tubercle bacilli into the femoral arteries of animals. The reaction in the muscles supplied by the artery was noted at varying intervals. The first tuberculous lesions were observed in the intima and walls of the vessels; they then spread into the interstitial tissue. Involvement of the muscle bundles themselves was late and secondary in nature. In 1912 Ely and Cowan[12] buried cultures of bovine tubercle bacilli in the incised leg muscles of rabbits. After different periods of time, the muscles became the seat of a tuberculous process, nodular or caseous in form, which was confined chiefly to the fascia. The tendency to diffuse infiltration of the affected muscle, or extension to neighboring muscles, was not marked. Regional lymph nodes were occasionally affected. Metastatic lesions appeared frequently in the kidneys and lungs. Histologically, muscle fibers adjacent to tuberculous lesions showed degeneration and infiltration to round cells, leukocytes, and eosinophils.

The pathogenic and anatomical findings of tuberculosis of the human muscle coincide closely with the experimental data. Usually a preexistent and distant source (or associated lesion) of tuberculosis can be found in the lungs[13], intestine[2], bone[14], iris[15], and genital organs[13]. In some cases where such a focus cannot be demonstrated, a definite family history of active tuberculosis is obtainable. Clairmont and his associates[5] report a case of direct inoculation of the muscles of the thigh by autopyotherapy. The essential lesion, which varies in size from a pea to a grapefruit, is situated in the interstitial tissue or along the continuity of the muscle. It may be solitary or multiple, isolated in a single muscle or distributed in several separate muscles. Hematogenous involvement has been described in practically all muscles, especially those belonging to the extremities, the abdomen, and the trunk, such as the supinator longus[6, 16], the triceps[17], the biceps[14], the palmaris longus[18], the flexor digitorum sublimis[19], the extensor digitorum[13], the glutei[20], the quadriceps[4], the rectus femoris[21], the obliquus internus abdominis[22], the pectoralis[20], and the sternocleidomastoid[23, 15].

Hanke[20] distinguishes in general four types: fungoid form, nodule, cold abscess, and sclerosing myositis. The first three types may exist concurrently or they may represent different stages of the same process advancing to necrosis and caseation. In our case, the swelling was first nodular; with softening, and with increasing size, it was converted into a cold abscess. Hanke's fourth type, two examples of which have been studied[24, 25], is characterized by a distinct inflammatory reaction in the interstitial tissue; fibrosis predominates with little tendency to caseation.

Pilliet[26] formulated our knowledge of the histological picture by studying serial sections of diseased muscles. The earliest changes appear in the walls of the vessels and in the interstitial tissue. Tuberculous nodules undergo central necrosis. Cold abscesses, when formed, possess distinct walls. Calcification and fibrosis take place sparingly; extensive

spreading, however, is not the rule. Muscle fibers suffer from compression and simple atrophy. They also manifest different degrees of degeneration,—hyaline, waxy, vacuolar-cellular infiltrative, and hemorrhagic.

Definite bacteriological conclusions cannot be drawn from the literature because of the paucity of complete investigations. In the case cited, tubercle bacilli were isolated by animal inoculation and proved to be of the human group. Müller [4] and Reverdin [14] also demonstrated bacilli.

Sex plays no significant part as a predisposing factor. Adults in the third and fourth decades are most frequently affected. The youngest patients, aged seven and ten years, were reported by de Quervain [23] and Kirmisson [27]; the oldest, aged seventy years, by Kaiser [28]. No instance of this affection has been noted in the negro. Many authors attest to the importance of trauma as an exciting cause.[5, 15, 18, 20, 29, 30]

Hematogenous tuberculosis of the muscle is slow and insidious in its onset. A history of previous or existing tuberculosis in the patient or his family may be present. Swellings, which arise in the muscles and grow slowly but progressively larger, comprise the initial complaint. Because pain is not usually or prominently associated with the swelling, months or years may elapse before a physician is consulted. In the late stages, when the swelling is large in size, muscular movements become limited. The constitutional symptoms occurring inconstantly include slight fever, loss of weight, malaise, and sweating. Physical examination reveals single or multiple masses in one or many muscles, varying in size from a pea to a grapefruit. They seem encapsulated and are ordinarily movable and elastic, but become fixed and hard upon contraction of the muscle. In spots they may be firm, soft, and fluctuant. Pressure elicits tenderness. Communication with the skin, which is usually free, and with the tendons seldom takes place. Regional lymph nodes are rarely involved. The tuberculin test yields positive results. In some cases, there is a slight leukocytosis and monocytosis. In a few instances, material has been aspirated by diagnostic puncture but no bacteria have been disclosed on smears. Habermaas [3], however, found tubercle bacilli.

Clinically, hematogenous tuberculosis of the muscle is most often mistaken for sarcoma. In the differential diagnosis there enter the chronic granulomata (lues, leprosy, actinomycosis), malignant tumors, benign tumors (angioma, lipoma, neurofibroma), and pseudotumors (bursa or tendon cysts, echinococcus cysts, and hematoma). In one case, with involvement of the abdominal muscles, cholecystitis was considered [21]. Before a final diagnosis of hematogenous tuberculosis of skeletal muscle is made, direct extension from a neighboring focus should be ruled out by careful clinical, roentgenographic, operative, and pathological observations.

Although fibrosis and calcification occur to some extent, spontaneous healing in the usual case is not to be anticipated. Except for sclerosing myositis, in which the tendency to fibrosis is notable, the disease is chronic and generally progressive. The eventual prognosis depends upon

the severity of the coexisting tuberculosis, upon the number and the distribution of the muscle lesions, and upon the type and the time of therapeutic intervention. It is well to remember that an isolated tuberculous focus in muscle may become a fruitful source for miliary dissemination in other organs through the blood and lymph routes.

Therapy must be adapted to the type of involvement. Surgical extirpation is indicated in cases showing solitary cold abscesses or a few isolated nodules. Wounds heal by first intention; symptomatic and functional results are good except possibly in cases where the muscle fibers must be cut. Hanke [20] recommends roentgen-ray therapy for the fungoid form, innumerable nodules, and excessive granulations following surgical excision. Puncture of the nodules and abscesses with an injection of ten per cent. iodoform and glycerine has proved of little value. General hygienic measures, including diet, rest, and sunlight, should be prescribed.

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FRACTURES OF THE PATELLA

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From the Fracture Service of the Massachusetts General Hospital

During the period of time allotted to this study, there have been fifty cases of fractured patella in the Massachusetts General Hospital. Of thirty-eight of these cases end results are available; nine, although treated as ward patients, could not be traced; and three were treated in the Emergency Ward and Out-Patient Department only.

Age, Sex Incidence, and Distribution

The youngest patient in this series was twenty years of age, and the oldest, seventy-two years. The age table (Fig. 1) shows that the greatest incidence was in the decade between thirty and forty.

The sex distribution was thirty-four males and sixteen females, or practically twice as many among men as women.

Twenty-five cases involved the right patella; twenty-three, the left; and two were bilateral. It is interesting to note that, in four cases, fractures of the opposite patella had taken place in previous months or years. A fifth patient fractured first the right patella by muscular strain and, within forty-eight hours, fractured the left patella in the same manner.

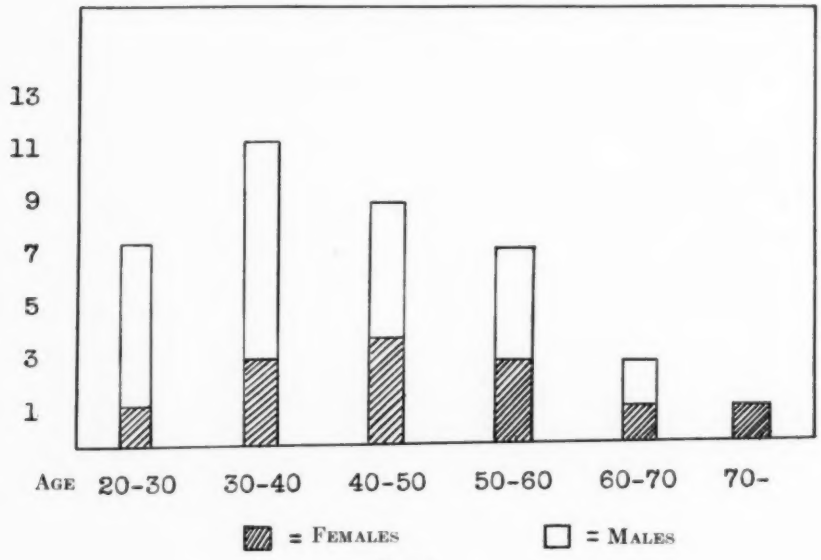

FIG. 1

Since a total of 4066 cases were studied in this entire series, the incidence of fracture of the patella is a fraction over one per cent. (1.229%). Inasmuch as in five of these cases, or ten per cent. of all the patellar injuries, the opposite patella had been fractured at some previous time, it seems that this tendency is more than can be explained on the basis of coincidence alone.

Mechanism of Injury

The mechanism of injury was that of direct trauma in thirty-five cases and of muscular strain only in twelve; it could not be accurately determined in three. Many of the cases of direct trauma were obviously not impact fractures alone, but were a combination of muscular strain with direct injury superimposed; in some instances either force working singly was probably not sufficient to produce the fracture. However, the comminuted fractures and those that were compound were undoubtedly due to direct force primarily.

Occupation

An analysis of the occupations failed to reveal any marked occupational hazard for this particular injury. Almost every walk of life was represented, there being a natural excess of housewives among the women. There were three carpenters in the group.

Type of Fracture

Forty-seven cases were simple fractures; three, compound. Of the former, thirty-four were transverse, one longitudinal, one oblique, and two were chips,—off the lower edge in one instance, and the upper edge in another. Twelve showed no displacement of fragments; the rest were displaced. A few of those that showed little or no displacement were operated upon; but most of these were left to heal spontaneously because the lack of separation indicated a probable absence of extensive tear in the lateral capsular expansion.

Complicating Injuries

In six cases there were present, at the time of admission, other injuries more severe than the fracture of the patella. In two of these there was no displacement of fragments and the patella did not require operation, although the patients required forty-eight and seventy-seven days, respectively, in the hospital for their other injuries. By this time, their fractured patellae were sufficiently healed so as not to prolong disability. Four cases, in spite of severe complicating injuries, had widely separated fragments of the patella, requiring delayed operations. These complicating injuries undoubtedly increased the hospital stay and prolonged disability somewhat.

Method of Treatment

Thirteen cases were treated without operative methods. These were all of individuals in whom the patellar fragments were not widely separated, whose capsules were apparently not torn, or whose complicating injuries prevented any safe surgical approach to the region of the patella. Thirty-seven cases were operated upon. The preoperative stay in the hospital averaged eight and one-half days. This seems a little longer than necessary, but in the average were included many long delays, due to complicating injuries, injured soft parts near the fracture, the patient's general condition, etc. In the uncomplicated transverse fractures, there was less delay and the average time for preparation of the skin, elimination of acute reaction in the joint, etc., was approximately five days.

During this preoperative state, patients were usually kept comfortable in bed with the leg slightly elevated on a pillow and the knee held rigid by straight splints and with ice caps applied about the swollen joint. Forty-eight hours prior to operation the skin was carefully shaved, thoroughly washed with soap and water, followed by alcohol and a sterile dressing. The scrub, alcohol, and sterile dressing were repeated each twelve hours up to the night before operation. In the operating room the skin was prepared by various methods,—usually ether or benzine first, followed by iodine, picric acid, Scott's solution of mercurochrome, or acriflavine, according to the preference of the surgeon. The last named chemical fell into disuse, either justly or unjustly, due to the fact that there seemed to be some difficulty with perfect healing of the skin edges in two or three successive cases in which this drug had been used.

Most of the operations were performed through a long U-shaped incision with the bottom of the U half-way between the tibial tubercle and the lower border of the patella. Occasional cases were done through a longitudinal or an inverted U incision. No difficulty was found with any of the scars, as, regardless of how the incisions were placed, healing took place in such a way that no disability resulted therefrom. It was generally felt that the U-shaped incision gave a better opportunity to expose the entire damaged area, thus making the rent in the lateral capsule easily accessible, as well as having the whole operative field under observation. These scars were less conspicuous than the longitudinal ones due to the more natural cleavage lines, and possibly to a less disturbed blood supply.

TYPES OF REPAIR

It has been borne out for many years that the major feature in a repair of the fractured patella is to reestablish continuity in the great extensor tendon that extends from the thigh to the lower leg, the patella being simply a sesamoid bone placed in this tendon. Therefore, treatment should be based on perfect apposition of the torn fragments of this tendon in such a way as to insure healing, the suturing of the fragments of the patella *per se* being incidental, but of use in the repair, due to their firm attachment to the tendinous structures above and below, and to the

additional security obtained by bony union. It is too much to expect a simple fixation of the fragments of the bony structure alone to properly restore the parts to normal function. It seems, therefore, desirable to approximate the bony fragments accurately and directly by some means or other, as well as to carefully repair the torn capsule, particularly the lateral expansion.

At the Massachusetts General Hospital it had been the practice, for a good many years prior to this study, to rely entirely on a catgut approximation of the capsular tear and a long immobilization of the joint in plaster-of-Paris. This method of treatment gave excellent results in the majority of cases, but in many of them the disability seemed longer than it should have been and there were occasional cases with permanent loss of motion due, undoubtedly, to the long immobilization; also, fibrous union was common.

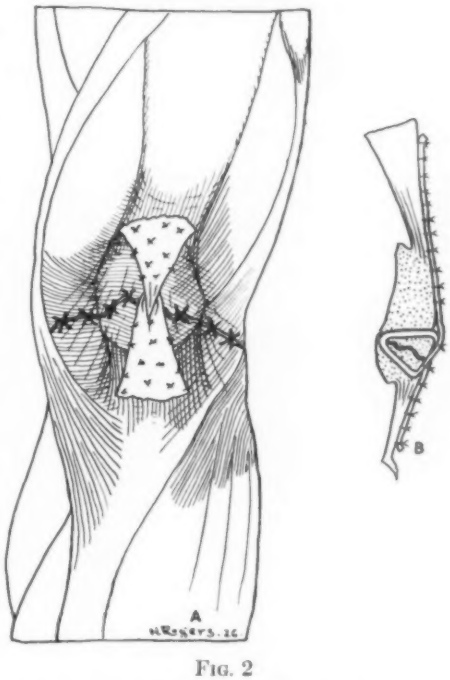

FIG. 2

A illustrates complete fixation of fracture of the patella. The graft can rarely be too long, as the more of it that is sutured to the quadriceps above, and to the prepatellar tendon below, the stronger is the fixation. Note the repair of the lateral extension tear with No. 2 chromic catgut.

B is a lateral diagram of completed fixation. Note the lack of joint penetration. (*By courtesy of Archives of Surgery.*)

In 1916 Scudder and Miller[1] reported on the end results in thirty-eight cases of fracture of the patella operated upon by capsular suture in the Massachusetts General Hospital. Ninety-four per cent. of these patients had full extension; sixty and five-tenths per cent. had full flexion; and fifty-seven per cent. had full flexion and extension. Sixty-three per cent. were able to work as well as before injury. Twenty-two cases were examined by x-ray for this end-result study and eighty-one per cent. showed bony union, while in nineteen per cent. absolutely no bony union was present. In some of the latter, however, there were good functional results. They felt, nevertheless, that accurate bony apposition and suture of the lateral expansion with resultant bony union was important. Scudder developed a clamp to hold the fragments together while the sutures were being placed and advocated a purse string of kangaroo tendon about the fragments. Following this study, it was felt that early motion of the joint was desirable, if this could be accomplished without disturbing the accurately apposed fragments. Wire was again

tried and found unsatisfactory, either because it would break at an inopportune time or, if the braided bronze variety was used, it offered difficulties in removal should this become necessary. Finally the development of the use of fascia lata in the repair of the fractured patella came about.

Phemister, in 1915, published a method of using a large sheet of fascia lata to bridge the gap of an old fractured patella by suturing the fascia to the quadriceps above and the prepatellar tendon below[2]. This method gave an excellent functional result. A modification of this method in acute fractures of the patella was first advocated and practised by Leland of our Service.

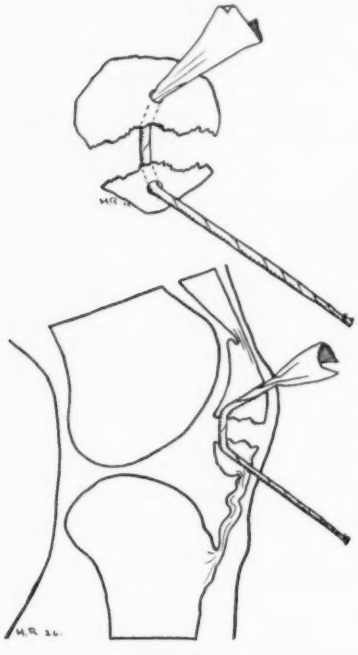

FIG. 3

Method used in fracture of the patella. Note the oblique fenestrations in the fragments. The fascia is three by twenty-four centimeters; the drill, five millimeters. (*By courtesy of Archives of Surgery.*)

Many of us had been using fascia lata for the repair of soft-part defects, as advocated by Gallie and Le Mesurier[3], and had found it extremely satisfactory material. It soon became apparent that its use in the treatment of patella and olecranon fractures was of value; drill holes were used, through which to pass the fascia. Early in 1923, at Wilson's suggestion[4], the writer used a rather large sheet of fascia lata passed through oblique drill holes once, then passed through itself, drawn taut, and the opposite ends sutured to the corresponding ligaments above and below (Figs. 2 and 3). A detailed report of this operation has been recorded[5].

Many modifications of this method can be used, according to the type of the case at hand. Two or three narrower strips can be inserted through smaller drill holes, for use in comminuted fractures of the patella, as advocated by Gallie and Le Mesurier in 1927.[6] Both ends of the fascial transplant can be divided into four or five strands, threaded to large-eyed needles, and sutured directly into the tendinous structures above and below, a modification suggested and used by Marble[7] (Fig. 4). Of course, in the plaque method the fascia lata may be many-tailed and incorporated into the tendon if desired. Some of the advocates of the plaque method drill bony structures and hold the fragments together temporarily by means of kangaroo tendon or heavy catgut (Fig. 5). Leland[8] prefers to use a transplant sufficiently wide to cover part of the lateral expansion suture, as well as the patella, and to suture the graft around its edges only, in an attempt to preserve its elasticity. Almost

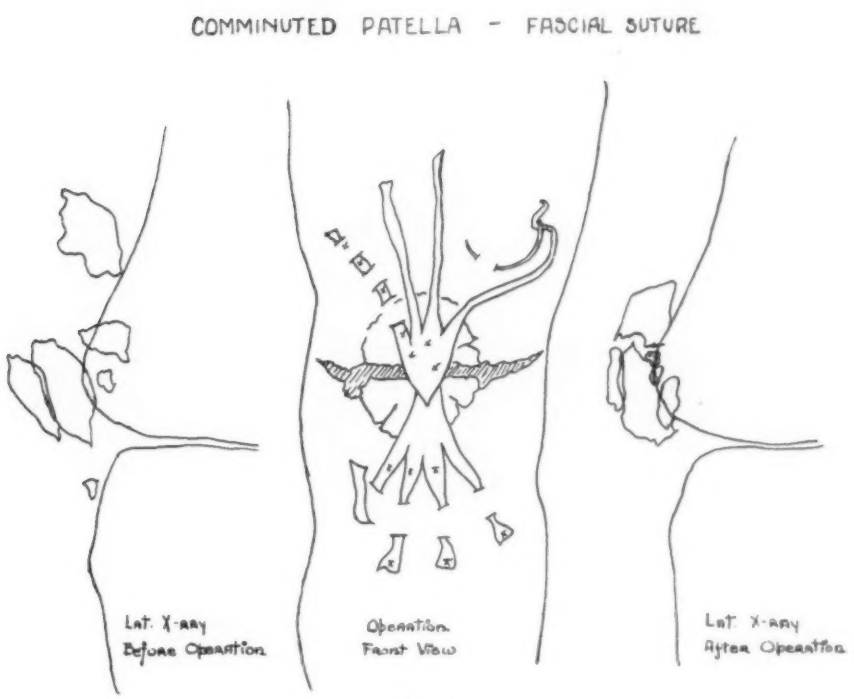

FIG. 4

every member of the Fracture Service has some modification that has satisfied his individual ideas concerning the use of this material. In addition to the cases cited below, well over 100 private cases of fractured patella have been satisfactorily repaired with fascia lata by various members of the Service.

Whatever method is used, it is the opinion of the entire Fracture Service, as evidenced by the following data, that fascia lata should be used intelligently in the repair of the average fracture of the patella. Most of us feel that there is some advantage in taking the material from the opposite thigh, inasmuch as early motion, which this method permits, is highly desirable to early return of function.

It was found that in the thirty-seven operative cases of this series, kangaroo tendon was used twice, and catgut was used four times. In five cases, fragments were drilled and held with kangaroo tendon over which a large plaque of fascia lata was placed. In ten cases, fascia-lata transplants were used and the bone not drilled. The repair was accomplished in fifteen instances by fascia lata being passed through drill holes in the fragments. It may be well to reiterate that, whatever type of fixation or support was used to the bone itself, the rent in the lateral capsular expansion was carefully repaired, usually with interrupted sutures of chromic catgut, but sometimes with strands of fascia lata instead.

AFTER-CARE

It is well to splint the joint with a plaster shell for twenty-four hours, particularly if the patient has had ether anaesthesia, after which no splint is necessary while the patient is in bed. Active motion is started at the end of seventy-two hours as a rule, in some cases a day earlier and in some a day or two later, depending on the general reaction, etc. Motion can be started somewhat earlier, with comfort, if the fascia-lata grafts have been taken from the opposite thigh. Passive motion should never be used. It is frequently necessary to assist the patient in his first attempts at motion. The amount of motion carried out each day is restricted to the limits of discomfort, and is gradually increased.

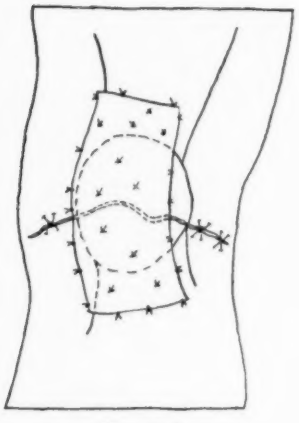

FIG. 5-A

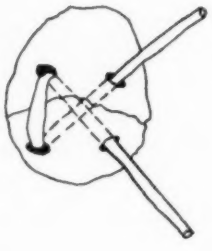

FIG. 5-B

Fig. 5-A. Illustrating a combination of suturing the lateral expansion and reinforcing the quadriceps and prepatellar tendons with a plaque of fascia.

Fig. 5-B. Small drill holes may be placed through the fragments of the patella, which is first fixed with kangaroo tendon over which a plaque of fascia may be used.

In some timid patients the leg may be suspended to advantage in a Thomas splint with a Pierson attachment. The patient is allowed out of bed in a week. Weight-bearing can usually be started at the end of two weeks. It is well to support the leg on a posterior splint when the patient is first out of bed, and crutches should be used until the patient has thoroughly regained his equilibrium. Usually both supports can be safely discarded after the fourth week. Complete motion is expected within twelve weeks from injury, and in the majority of uncomplicated cases the patients should be able to resume their usual occupations shortly thereafter.

The average number of days in the hospital was forty per person. The period, of course, was somewhat shorter in the uncomplicated simple transverse fractures of the patella, but this average includes all of the complicated cases. The average time until return to work for the entire group was twenty-four weeks,—this is in spite of compensation laws, which undoubtedly caused prolonged absence from work in a great many instances, and of complicating injuries in other cases. On the other hand, this is fairly well offset by the fact that a certain number of housewives returned to their duties shortly after their return home from the hospital.

Complications—Postoperative

There was one death on the operating table (in Case 6), thought to be due to a cerebral accident of some sort; it is difficult to explain. It was a medicolegal case and no autopsy was performed. One wonders about fat emboli or the possibility of death from the anaesthetic.

There were two small hematomata in the wounds and two cases of minor sepsis. None of these four complications prolonged disability. There were also two cases of fairly severe upper respiratory infection. There was one case (Case 28) of refracture of the patella three months after the first injury. The repaired capsule had been reinforced by a fascia-lata plaque, the patellar fragments had not been drilled, the patient was uncooperative and had regained very little motion at the time of her second injury which, however, was sufficiently severe to have produced a fracture had there been no previous separation. The second repair was accomplished by kangaroo tendon through drill holes and a plaque of fascia lata over the suture line. The final result was perfect, although the patient had a total disability of one year.

END RESULTS

The summary of the end results showed that twenty-eight out of thirty-eight cases were granted a perfect score of A^4 F^4 E^4. Thirty-four had perfect economic results; thirty-two had perfect functional results; and thirty had perfect anatomical results. Five cases were graded 3 anatomically; three cases were graded 3 functionally; and one case was graded 3 economically. There was no incidence of any case studied being graded below 3.

In twenty-four cases out of the thirty-eight on which end results were available, definite mention of the type of union was made. Twenty-two of these were said to have bony or solid union and two fibrous union. Inasmuch as the anatomical grading was made on the basis of bony union and accurate apposition of fragments, it is fair to assume that in all of the thirty cases graded 4 anatomically, bony union was present. In addition, Case 8, Case 20, and Case 31 were graded 3 anatomically, but definite statements were made that there was bony union.

The two cases of fibrous union are interesting. Case 1 was a compound fracture operated upon fifty-three days after injury. Kangaroo tendon was used through drill holes to hold the fragments in apposition, the capsule was sutured, and a plaque of fascia lata was placed over the patella. This is the only case in which fascia was used where bony union failed to take place. Case 14, recorded as fibrous union, had only a capsular suture with catgut and kangaroo tendon. This case was complicated by a fracture of the tibia on the same side.

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ADOLESCENT OSTEOCHONDRITIS OF THE SYMPHYSIS PUBIS

With a Consideration of the Normal Roentgenographic Changes in the Symphysis Pubis

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Disease processes seldom involve the symphysis pubis, and, of those that do, only traumatic diastasis of the symphysis has been adequately described. Tuberculosis or osteomyelitis are rarely seen. Occasionally after a suprapubic cystotomy, a suppurative osteochondritis—osteomyelitis to all intents—may develop. The region of the symphysis is also occasionally involved in tumor metastasis, but the symphysis itself seems to be spared.

The case which is being reported is unique in that no record of a similar condition has apparently been published. It also is important because of its medicolegal significance.

CASE REPORT

A young man, seventeen years of age, while working on a construction job, August 15, 1932, was pinned between a slowly moving auto truck and a fence. Most of the contact was made with the lower part of his abdomen; his more than usual height prevented any contact higher up. The time of contact was brief, probably not exceeding one minute. He at once complained of severe pain in his abdomen and was sent home and put to bed. One of us (M. B.) saw him the next day at his home, when the pain, which was definitely present over the region of the symphysis pubis and still radiated to each groin and down the inner side of each thigh, had gradually become duller. He was never unconscious, nor did he vomit. However, he had experienced some nausea. There was no difficulty in urination and defecation, and no passage of blood in either urine or stool.

On examination, it was ascertained that no tenderness was present in the bony parts of the symphysis pubis, but that all tenderness and pain were confined to the muscles, especially over the lowest part of the right rectus abdominis and pyramidalis muscles. The left side was much less tender. No muscular spasm or rigidity were present, and the abdomen was soft and not tender. On tensing the abdominal muscles by assuming the sitting position from the lying position, it was made very definite that all tenderness was muscular. No swelling and no ecchymosis were seen. A urine examination was negative for blood.

Rest in bed, with an ice bag to the lower abdomen, was advised. Although it was urged, a roentgenogram was not taken because of financial reasons. A diagnosis of contusion of the lowest part of both the rectus and the pyramidalis muscles was made.

That this diagnosis was correct was borne out by the fact that on September 7 he was entirely symptom-free and had been so for a week. He was allowed full freedom of activity, but was cautioned about overdoing in athletics, especially football.

On October 25, he was seen again and was still symptom-free. Examination of the region of the symphysis pubis was entirely negative.

On December 26, four months and eleven days after his original injury, he returned

FIG. 1

Roentgenogram, taken four and one-half months after injury, showing the wooliness and the fragmentation of the symphysis pubis.

FIG. 2

Roentgenogram, taken about nine and one-half months after initial trauma, showing almost complete subsidence of the disease process within the symphysis pubis. The symphysis is, however, definitely irregular.

again. He had experienced a dull, dragging pain in the region of the symphysis pubis for a week. This pain radiated up the abdomen, down the inner side of the thighs, and across to each groin. He had been rowing for the past few months in an effort to make the school team. Otherwise, no trauma was known and the pain seemed to have arisen spontaneously. He walked perfectly normally. No other symptoms were present.

On examination, it was found that all tenderness was now bony, and not muscular at all. Pain was very marked over the right pubic bone, just lateral to the symphysis pubis, and extended from its superior to its inferior borders. Pain was also present over the left half of the symphysis pubis and over the symphysis itself, but to a lesser degree. There were no swelling, abscess, or sinus opening, and no signs of recent injury. The patient did not complain of backache, nor was there tenderness at any point in his back. That backache may be present in disease of the symphysis pubis, even long before attention is directed to the symphysis pubis, is a fact that should not be forgotten. This is so by virtue of the fact that the symphysis pubis is a fulcrum in the ring of the pelvis.

A secondary disease process had evidently appeared in the symphysis pubis, following an initial trauma four and one-half months previously. A preroentgenographic diagnosis of adolescent osteochondritis of the symphysis pubis was made. The disease seemed analogous to those other disease processes of growth encountered secondarily.

FIG. 3

Roentgenogram, fifteen months after initial trauma.

A roentgenogram (Fig. 1), taken a few days later, showed an irregular, woolly appearance of the symphysis pubis, with an excess of the mammillation noted in many symphyses at this particular period. There were several free bone fragments in the space of the symphysis itself. The process seemed more advanced on the right side. The epiphysis of the tuberosity of the ischium was noted as unaltered. A phlebolith was present over the ascending ramus of the left pubic bone. The hip joints and the sacro-iliac joints were negative.

The patient was given baking and massage treatments over the affected region three times a week. A polo belt, to fix the symphysis pubis, was ordered. After each treatment, the patient complained of a temporary exacerbation of pain which lasted several hours.

By January 11, 1933, the symptoms were greatly lessened. Tenderness was present only in the superior and medial aspects of the right half of the symphysis pubis. A rectal examination elicited no pain in the pubic bones.

On January 25, he had had no pain objectively or subjectively for over a week.

On January 28, he was admitted to the Hospital for Joint Diseases for one day. A quantitative tuberculin test, a blood Wassermann, a routine urine examination, and a blood count were made; and, finally, a stereoroentgenogram of the symphysis pubis was taken. The various laboratory tests were all negative. In clinching the diagnosis, it was considered quite important to have a stereoroentgenogram taken, since overlapping shadows and the shadows of soft tissues within the pelvis and gas and feces within the bowels render a flat plate of the symphysis pubis difficult to interpret. The stereoroentgenogram showed an advance in the disease process, although clinically it had sub-

sided. The disease process was greater on the right side, and the fragmentation and woolly appearance of the symphysis pubis were very nicely demonstrated.

In an effort to stimulate the blood supply to the area, treatments were resumed on February 11. These were kept up until March 4, at which time the patient was still symptomless, both subjectively and objectively.

On June 1, another flat roentgenogram (Fig. 2) was taken. At this time, there was almost complete subsidence of the disease process; the line of the symphysis pubis was almost smooth, and the irregularity suggested only slightly the previous woolly appearance. A questionable free fragment was still present in the left superomedial aspect of the symphysis pubis. The shadow of the phlebolith was still noted.

A final roentgenogram, taken November 24, 1933 (Fig. 3), showed that the disease process had almost spent itself, although the symphysis was still somewhat more irregular than is usual. This was more marked on the right side, and the upper half of the right pubic bone showed an incomplete dissecting process, outlining a denser shadow which might be the site of a future free bone fragment.

The patient was symptom-free, and an examination of the pubis was negative.

COMMENT

In looking over the literature on alterations in the symphysis pubis, it was quickly found that little had been written on the normal roentgenographic appearance of the symphysis pubis. For the appreciation of this case, it was decided that a study of the normal symphysis pubis, especially that of the second decade, would form a basis for the consideration of this

FIG. 4

Roentgenogram showing the symphysis pubis of a young girl aged ten years. A questionable fragmentation of the upper edge of the right pubic bone is seen. The persistence of the pea-sized swelling at the ischiopubic junction is noted.

TABLE I

STUDY OF 127 ROENTGENOGRAMS OF THE SYMPHYSIS PUBIS

Ages of Patients (Decades)	No. of Roentgenograms Examined	Male	Female
0–9 years inclusive	24	9	15
10–19 years inclusive	29	14	15
20–29 years inclusive	16	5	11
30–39 years inclusive	15	8	7
40–49 years inclusive	17	6	11
50–59 years inclusive	18	10	8
60–69 years inclusive	7	3	4
70–79 years inclusive	1	0	1
	127	55	72

heretofore undescribed condition. Therefore, a study was made of 127 roentgenograms of the symphysis pubis. A larger number could have been studied, but sufficient information was obtained from these 127 roentgenograms to explain this condition.

NORMAL ROENTGENOGRAPHIC APPEARANCE OF THE SYMPHYSIS PUBIS

The symphysis pubis of the very young is broad, flaring outward above and below. There is no suggestion of mammillation. The ischiopubic junction does not join until the age of four, and the site of junction is represented by a spherical swelling the size of a cherry pit. This swelling may show two or three areas of vacuolation, each bordered by a line of condensation. This is normal and is not indicative of osteochondritis. The site of junction may also be V-shaped, the arm of the pubis fitting into the groove of the ischium. Full union takes place at about the age of seven, but may be delayed in certain conditions, as in congenital dislocation of the hip. From the tenth year on, the symphysis pubis often shows horizontal grooving or mammillation, which is more manifest in the earlier years of the second decade. Todd has compared this undulating line of cartilage over bone to an epiphysis over a diaphysis. Lang and Haslhofer have shown that, at points of not infrequent mucoid and oedematous degeneration of the cartilage, an indentation occurs which is smoothed over ultimately by progressive ossification. This appearance of the symphysis pubis is detected in roentgenograms taken over a period of years, but is usually most marked between the ages of twelve and fourteen.

In two cases there was a seeming fragmentation of the symphysis pubis, somewhat comparable to that seen in our case. No symptoms were referable to the symphysis pubis, and, since the plates were not stereoscopic, it was not possible to rule out extraneous shadows.

Toward the age of twenty, the edges of the symphysis pubis become smooth, are more vertically placed, and approach the adult type. In the

FIG. 5

Roentgenogram showing the normal symphysis pubis of a boy of fourteen years. Note the normal grooving or mammillation of the symphysis. A growth disturbance in this type of symphysis is believed to have caused the unusual changes observed in our case.

third decade, the symphysis pubis is more or less vertically placed, with straight and sometimes concavoconvex edges. It is narrow, its width being about one-eighth of an inch. Some sclerosis of the edges is noted, indicating increasing ossification of the cartilagirous face. Mammillation, or grooving, is no longer seen. One case in the third decade showed a pregnancy diastasis of the symphysis pubis, of moderate degree, with some bony fragmentation within the symphysis. This adult type of symphysis pubis, seen in the third decade, is also noted from the ages of thirty to forty-five. From forty-five to sixty years of age, the typical configuration of the symphysis pubis is still

FIG. 6

Roentgenogram of the normal symphysis pubis of a young man, aged twenty-one.

unaltered; however, the edges of the symphysis may be more sclerotic than normal, and the interspace may be reduced to less than one-eighth of an inch. Simple arthritic spurring is seen superiorly, and ossification is very seldom noted in the inferior arcuate ligament. In one case, a gouging out of one face of the symphysis pubis, with a free bone fragment in the interspace, was seen in a symptomless symphysis pubis. In another, a double gouging out at the same level of the symphysis pubis, without bony fragmentation, was seen.

From sixty to seventy-five years of age, an increase of the lipping, narrowing, and sclerosis is observed, although never of an advanced degree. In one case, excavation of the superior border, with bony fragmentation, was present; in two cases, the pubic bones were involved in metastatic processes, but the symphysis pubis itself was spared. The authors have not seen a synostosis of the symphysis pubis.

It is with uncertainty that one differentiates between the male symphysis pubis and that of the female. The acuteness of the male pubic angle and the greater height and possibly narrower interspace of the masculine symphysis pubis are not distinctive enough features to warrant determination of sex with certainty.

Accurate roentgenographic estimate of the symphysis pubis is made more difficult by the presence of shadows extraneous to the pubis, but

FIG. 7

Roentgenogram showing mild pregnancy diastasis of the symphysis pubis of a woman aged twenty-three. Slight bony fragmentation within the interspace.

which apparently lie within it. The most common of these are the presence of phleboliths in the pelvic veins and the overlapping shadows of the coccyx and of gas and feces within the bowels. The superior angle of the symphysis pubis, which is usually not sharply outlined, may seem to be the seat of areas of rarefaction, of increased density, or of fragmentation. A whole host of other more easily differentiated shadows is tabulated by Köhler. Again, certain normal areas of rarefaction in pubic bones have been pointed out by Heeren, indicating that the pubic bones are not of uniform density throughout. To avoid confusion, stereoscopic roentgenography of the symphysis pubis should be done in any case requiring special examination of that region; grave errors can thus be avoided.

FIG. 8

Roentgenogram showing the symphysis pubis of a woman of forty-eight years, who presented no local symptoms or signs. Gouging out of one face of the symphysis pubis is seen, with bony fragment in interspace.

We have had no experience with the changes in the symphysis pubis in pregnancy. One group contends that diastasis does not occur, while another notes it frequently. Anatomically, gross and microscopic changes of fissuring, hemorrhage, cysts with cartilaginous bodies therein, and microscopic fractures have been reported by several authors. These changes are noted almost uniformly during pregnancy and regress after delivery, so that no trace of them is found a year or more later.

These anatomical changes undoubtedly predispose to pregnancy diastasis. They may not be roentgenographically visible. Thus Reis, Baer, Arens, and Stewart contend that no roentgenographic changes have been noted in any patient of their series at any time during pregnancy or thereafter.

Diastasis may be noted in infections of the symphysis pubis. The separation may develop fairly rapidly in acute osteomyelitis. The senior author has had an opportunity to observe a less rapid diastasis in one of his patients with tuberculous osteomyelitis of the symphysis pubis.

The anatomical changes in the symphysis pubis as age progresses are now being investigated by Dr. Charles Sutro. This study should establish an anatomical basis for the roentgenographic changes noted in the various decade groups, and for the particular changes observed in pregnancy. The effect of suppurative processes upon the fibrocartilage of the symphysis pubis should also be studied experimentally.

The understanding of the case here reported depends upon the appreciation of the presence of the normal grooving or mammillation of the symphysis pubis in the second decade.

The changes in the symphysis pubis of our patient were undoubtedly due to a growth disturbance at a period in which ossification was active but incomplete. The original trauma probably injured the blood supply to the symphysis pubis.

The pathological changes can be inferred to be an aseptic, subchondral necrosis, comparable to the pathological changes observed in other osteochondritides, although this inference is open to criticism since no specimen is available. Many unrecognized cases, asymptomatic as well as symptomatic, must occur. The condition is definitely benign, and clinical recovery is fairly rapid. Roentgenographically, however, the symphysis pubis heals in such a manner that there is more irregularity of the symphysis than is usual.

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PHYSIOTHERAPY IN FRACTURE TREATMENT

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Physiotherapy should have, as it has not had in the past, a very important rôle in the treatment of injuries, particularly fractures.

That it has not played such a rôle is in part due to ignorance or indolence on the part of the surgeon, in part to extravagant and illogical claims as to what can be accomplished.

In fact, unfortunately, one commonly hears *all* physiotherapy for fractures condemned, and swept aside by the surgeons into one waste basket with the much abused "B. & M."—baking and massage.

So it is that, so far as fractures go, physiotherapy seems to have fallen upon evil days, suffering, as so many things are, from depression following undue expansion.

And this boom, like others, had its rise in enthusiasms, not logical thought and study.

But physiotherapy rightly used is of the greatest value in fracture work.

Only, we have to know something about using it.

And, first, what is physiotherapy?

A good definition is hard to formulate.

It means the application in medical practice of physical means other than medicaments (and foods) or surgical procedures.

This is a large classification, but perhaps essentially correct.

Early physiotherapy was massage.

From early history—in prescriptural times—man has believed in the efficacy, in disease and injury, of the "laying on of hands", whether that might mean the blessing of "the King's touch" or the more intimate and heavy-handed ministrations of the rubber or masseur.

Also, ineradicable is the belief of all of us in the "rubbing in" of liniments, lotions, and salves.

Only the strong-minded can go so far as really to believe that it is only the rubbing that matters—and that that doesn't matter very much.

Almost as firmly implanted is the belief in electricity as such, and it probably never will be possible really to impart to the public the conviction that electricity—the current *as such*—introduced into the human body, has never been shown to be of the slightest use.

The sensory and psychic effects remain, and in this direction the use of the various currents may have some excuse—and even reason.

But surely nearly, if not quite, all electrotherapy is suggestion, delusional, not directly therapeutic.

Passive exercises, with or without stretching, used from time immemorial, are really of very limited value, but have only lately been sup-

planted, and only in part at that, by active exercises, which form far and away the most important item in fracture treatment by physiotherapy.

This includes, of course, both ordinary active movements and movements in which the weight of the limb is supported by the hand of the operator or in a supporting medium, be it water or the paraffin bath. There is a definite distinction between active supported exercise and non-supported exercise of the usual type.

Heat, obviously comforting, has unquestioned value, but is less important than is believed, in treatment of injuries at least. Its main function is in preparation for exercises, and its action is pleasantly sedative to pain, sedative to spasm, stimulating in the sense of promoting some hyperaemia. It is applied in many ways.

But lately we have had advocated, not only baking lights for heat, but lights of all sorts and all wave lengths, each, according to its prospectus, adapted to the accomplishing of some special purpose,—marvellously efficient.

Probably it all comes to this,—all lights give heat, penetrating more or less, never penetrating very far. Beyond this, sunlight direct, or sunlight transmitted through quartz, gives the full range of the spectrum, and quartz-mercury-vapor lamps, as such, give certain rays, particularly ultraviolet of medium wave length, effective as the vitamins are effective (particularly vitamin D) in promoting metabolism, and in laying down calcium. This sort of light therapy may promote fracture repair by way of rendering blood calcium available. It has nothing to do directly with promoting return of function in joint or muscle, since the chemical changes occur in the blood in or just beneath the skin only, as far as is known.

Now it may be of service to run over very briefly the various "modalities", so called, of electrical methods and the variety of lights, before going on to what we believe are the most important things we can do to promote fracture repair and the return of use to the limb.

Static electricity has probably no more value than that of pleasant titillation, and the effects of the technical scenery of the surroundings.

The *galvanic* current has testing value, is not reliably available for muscle work, and has not been shown of use in promoting absorption or repair.

Faradic current direct may be disposed of in the same phrase.

Interrupted sinusoidal currents have value particularly for muscle stimulation,—sometimes very important.

The difficulty has been that with muscle function artificially induced has gone painful muscle contraction and often painful skin contact.

That is the difficulty with direct faradic and with the galvanic currents.

At the time of the War appeared the Bristow coil, used then and thereafter with real results; and more recently a much improved machine has become available,—the *Morton-Smart* model, not yet widely introduced.

These utilize an interrupted high-frequency faradic current, and in use make possible really painless *non-spastic muscle contractions.* Of their routine use, more later on.

Diathermy, much discussed, is the method by which opposed interrupted high-frequency currents are so applied that *at their meeting point* they develop heat *within the body,* and within a limited area more or less accurately determined.

The fact that the heat so generated is of electrical origin is a matter of concern only in relation to skin contacts. *Diathermy* is not a form of electrical treatment at all, but the application of heat.

As to what is actually done in generation of heat in the body, many extravagant claims have been made in forgetfulness of the fact that the internal cooking of a steak concerns dead tissue, and is in no way comparable to the heating of tissue surrounded and permeated by a rapidly circulating blood stream.

Actually, however, heat is developed and may be made use of, with due caution, to produce vessel dilatation and local hyperaemia. *Diathermy* seems to promote bone repair in this way to some small extent, and has a place in fracture treatment in selected cases.

Now as to what may actually be accomplished in fracture treatment through heat and lights.

Heat is applied in many ways:

Baking—no light directly applied.

Heat directly from the ordinary bulb, perhaps the most efficient form.

Infra-red radiation—the "black light", invisible as light, of relatively high heat value, but with very little penetration, except in short wave infra-red rays.*

Green and yellow lights, which seem to have no particular rôle, physiologically.

Violet and ultraviolet rays, with very low penetrating power.†

These last are the rays that exert germicidal and chemical powers, the only differentiated rays that act specifically, and not just as heat.

For our discussion, their value is that they produce changes in blood composition, and in the composition of the skin.

To come back to heat, as such. There is some virtue in the hot sand baking which combines heat and soft pressure on exudates. The same may be said of the hot paraffin bath, also convenient as a supporting medium for active exercises.

Heat and gentle massage are combined in the whirlpool bath, with the air intake of the Hutchins or Titus machines. Useful, decidedly *not* indispensable.

* Most servicable in wave lengths of 7,500 to 14,000 Angstrom units, running up to 50,000, but with danger of too much venous congestive effect in the higher brackets.

† Penetration variously estimated from 0.01 millimeter up, surely not over 0.1 millimeter.

The installation of elaborate plants is probably nowhere needed, certainly not for fracture treatment. A diathermy outfit is needed, perhaps a Smart machine. Nothing else is important except a baker of some sort.

The physiotherapy treatment of fractures should be, very definitely, *not a matter of machines* or apparatus.

What we want to do is to secure repair with the least possible interruption of function.

Complete recovery of function depends on early resumption of function to a great degree.

Restoration of normal circulation means not only active repair, but also the removal of excess exudate, resulting in less excessive deep-scar formation,—less fibrosis of muscle and ligament.

Restoration of muscle activity means preservation of muscle nutrition,—function of joints.

The effective means to the end desired are massage, active motion, and heat.

If we have a *fresh* fracture, the first therapy, if there is effusion into the tissues, is massage *, to cause rapid absorption of blood and lymph under direct manipulation † until nearly normal conditions are restored.

Then comes the reduction and fixation.

Fixation we cannot sacrifice, but apparatus may very often be devised to give opportunity for early massage without sacrificing security, or plaster casings often may safely be cut out to allow this handling, with early motion of joints not intimately involved in the immobilization of the fracture.

Such massage must be gentle, persistent.

To this is added as soon as is safe the beginning of active motion‡. Otto J. Hermann, several years ago, began to cut out plaster over the front of the thigh in cases of hip fracture to allow massage and active motion, with no mishaps and with better results in function.

For several years, on the Bone and Joint Service of the Boston City Hospital, a couple of therapist aides have ranged the wards all day, under close surgical direction, carrying out massage and guarded movements on fractures as early as possible. This treatment has proved abundantly worth while in the average results.

Next, it is possible to get patients into convalescent apparatus much earlier than is usually done, and this means the free use of massage and active motion under control, during *early* convalescence.

And so we come to the later convalescent stage.

This should be the stage of real recovery of function *after weeks of careful physiotherapy.*

* Böhler has well understood the value of this.

† Anyone who has seen the disappearance of knee-joint fluid under the hands of a good masseur knows that more than stimulation of circulation is concerned here.

‡ Sometimes one may well substitute the stimulation of the Smart machine for controlled muscle action, but not as a routine.

Actually, too often, it is the stage when stiff limbs are handed over for the physiotherapist to *begin* on.

And that is the main trouble; for by that time:

The patient has had his fracture;
He has stiff joints not under control;
He has stiff muscles and has no power to use them;
He has a mind already grown clogged, or with the wires down between it and his muscles;
And effort hurts him.

So he is baked and likes it, and loafs and likes it,—and of this no end!

Heat and massage are well enough if we realize—and make the patient realize—that they are of use *only* as preparation for the active exercise and use which is his only salvation.

The real function of a Smart machine is to prove to him that he has real muscles, to make him synchronize his effort with the electric impulse until he learns how to do it himself.*

The physiotherapist is of vast use in two ways:

1. In devising exercises that are easy, utilizing gravity instead of fighting it,—exercises that the patient can learn to do with precision, exercises that risk neither loosening of a recent union, nor overtiring of muscles.

2. In making him do them, at home as well as in the office. In making *him* work, himself.

That is the essential thing,—to make it easy for the patient to bring about his own cure, making him understand that in the end no one else can do more than help *him*.

He must cure himself.

That is the essential doctrine of physiotherapy in fractures.

The prescribing of "baking and massage" in the routine way is not the use of physiotherapy, but a confession of ignorance as to what physiotherapy can do.

* We are quite aware that we are not agreeing with Smart in this estimate of the main value of such therapy.

RECURRENT DISLOCATION OF THE SHOULDER

BY TOUFICK NICOLA, M.D., F.A.C.S., NEW YORK, N. Y.

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This paper will be limited to further observations on the operation for recurrent dislocation of the shoulder which the author first described in 1929. Included in this paper is a report of thirty-two cases operated upon by the author.

Each case of recurrent dislocation of the shoulder should be studied to determine the exact pathology that is present. In considering the pathology, it is convenient to divide it into three groups: bony, capsular, and muscular.

In the *bony* group we may have:

1. Defects in the head of the humerus either acquired after the first dislocation, or due to atrophy of the head, infantile paralysis, or congenital defects.

2. Defects in the glenoid cavity, consisting of either acquired fracture of the edge or shallowness of a congenital type.

3. Fractures of the greater or lesser tuberosities of the humerus.

In the *capsular* group we may have:

1. Detachment of the joint capsule from the anterior or inferior margins of the glenoid cavity.

2. Enlargements of the joint from relaxation following repeated tears.

In the *muscular* group we may have:

1. Weakness of the supraspinatus and infraspinatus muscles.

2. Contracted pectoralis major, teres minor, and the latissimus dorsi.

From the pathological consideration, it is seen that in most cases there is usually a combination of two or three of these factors present and to repair only one leaves a loophole for recurrences. To repair all is very difficult and sometimes impossible. The following operation is in principle the same as the original, but has a few improvements and is described in more detail.

DESCRIPTION OF OPERATION

1. The incision begins just outside of the coracoid and passes downward for two and one-half inches in the line of the fibers of the deltoid (Fig. 1).

2. The deltoid fibers are divided by blunt dissection. At this point the circumflex nerve and artery may come into view crossing the wound. If so, care should be taken to avoid injuring them.

3. The tendon of the long head of the biceps is located by feeling for the bicipital groove. The tendon is then exposed up into the shoulder

TABLE I

SUMMARY OF THIRTY-TWO CASES IN WHICH OPERATION WAS PERFORMED FOR RECURRENT DISLOCATION OF THE SHOULDER

Name	Age	Sex	Occupation	No. of Dislocations	Shoulder Affected	Date of Operation	Stay in Hospital	Period Before Return to Occupation	Remarks
Case 1	20	M	Boxer	5 times weekly	Right	Apr. 6, 1928	6 days	5 weeks	
Case 2	27	M	None	2 times weekly	Left	Sept. 8, 1928	10 days	7 weeks	Epileptic, killed in automobile accident, Jan. 17, 1930.
Case 3	20	F	Student	6 times weekly	Right	May 14, 1929	10 days	6 weeks	
Case 4	25	M	Salesman	1 monthly	Right	Nov. 5, 1929	10 days	5 weeks	
Case 5	21	M	None	7 times weekly	Right	Nov. 17, 1929	14 days	2 months	Epileptic.
Case 6	18	F	Student	1 monthly	Right	Dec. 4, 1929	10 days	1 month	
Case 7	30	M	Painter	1 weekly	Right	Mar. 3, 1930	14 days	10 weeks	
Case 8	50	M	Physician	1 monthly	Right	Apr. 4, 1930	3 weeks	3 months	Bronchitis prolonged stay in hospital.
Case 9	24	M	Salesman	1 monthly	Left	Apr. 21, 1930	10 days	2 months	
Case 10	17	F	Student	4 times weekly	Left	June 24, 1930	14 days	2 months	
Case 11	24	M	Clerk	3 times weekly	Right	July 8, 1930	10 days	6 weeks	
Case 12	28	M	Plumber	2 times weekly	Right	July 8, 1930	14 days	10 weeks	
Case 13	35	F	Housewife	1 every 2 weeks	Right	Sept. 4, 1930	14 days	10 weeks	
Case 14	29	M	Laborer	1 every 2 months	Right	Feb. 7, 1931	10 days	3 months	
Case 15	21	M	Student	4 times yearly	Left	Feb. 9, 1931	6 days	3 weeks	
Case 16	40	M	Laborer	5 times monthly	Right	June 6, 1931	14 days	3 months	
Case 17	19	M	Baseball player	1 monthly	Right	June 6, 1931	10 days	6 weeks	
Case 18	20	M	Student	4 times yearly	Right	June 30, 1931	8 days	4 weeks	
Case 19	28	M	Laborer	3 times monthly	Right	Aug. 4, 1931	14 days	3 months	
Case 20	24	M	Student	8 times yearly	Right	Mar. 20, 1932	7 days	6 weeks	
Case 21	29	M	Plumber	4 times monthly	Right	May 4, 1932	18 days	4 months	
Case 22	37	M	Laborer	3 times weekly	Right	Jan. 4, 1933	3 weeks	11 weeks	
Case 23	17	F	Student	9 times yearly	Left	Apr. 9, 1933	10 days	8 weeks	Redislocation in 4 months. No dislocation since.
Case 24	22	M	Student	6 times yearly	Left	Apr. 14, 1933	6 days	3 weeks	
Case 25	20	M	Student	6 times monthly	Right	May 7, 1933	9 days	4 weeks	
Case 26	38	M	Laborer	1 monthly	Right	June 9, 1933	14 days	5 weeks	
Case 27	20	M	Student	4 times monthly	Right	July 11, 1933	10 days	19 days	
Case 28	19	F	Housewife	9 times monthly	Right	July 11, 1933	17 days	5 weeks	
Case 29	26	M	Laborer	4 times weekly	Left	Sept. 7, 1933	14 days	3 months	
Case 30	41	M	Laborer	1 weekly	Right	Sept. 14, 1933	3 weeks	8 weeks	
Case 31	38	M	Lawyer	4 times monthly	Left	Sept. 14, 1933	2 weeks	1 month	
Case 32	24	M	Student	1 monthly	Both	Oct. 3, 1933	10 days	3 weeks	

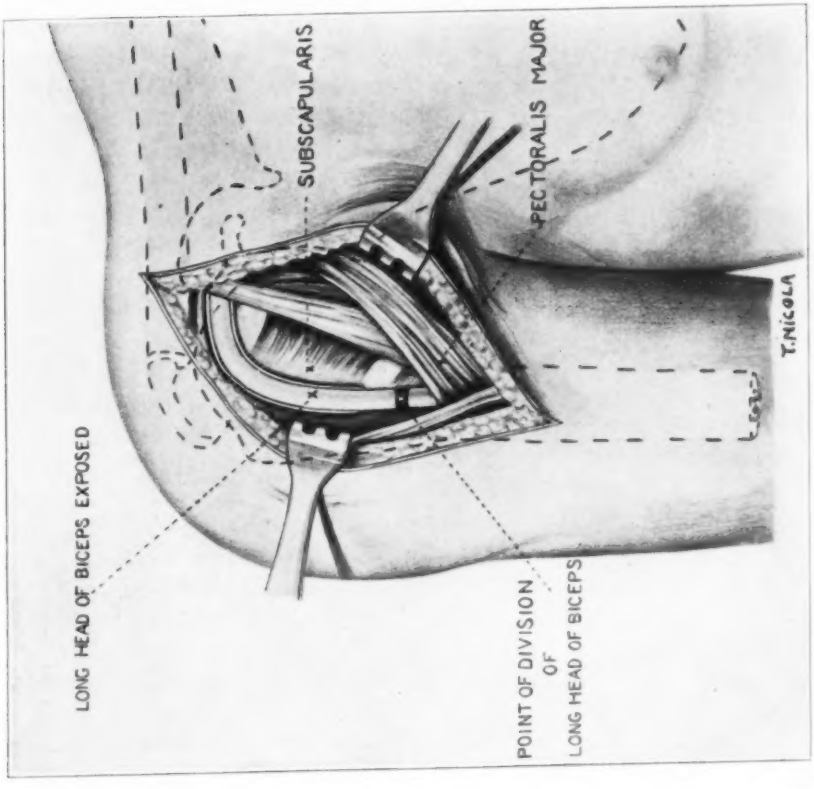

LONG HEAD OF BICEPS EXPOSED
SUBSCAPULARIS
PECTORALIS MAJOR
POINT OF DIVISION
OF
LONG HEAD OF BICEPS
T.NICOLA

FIG. 2

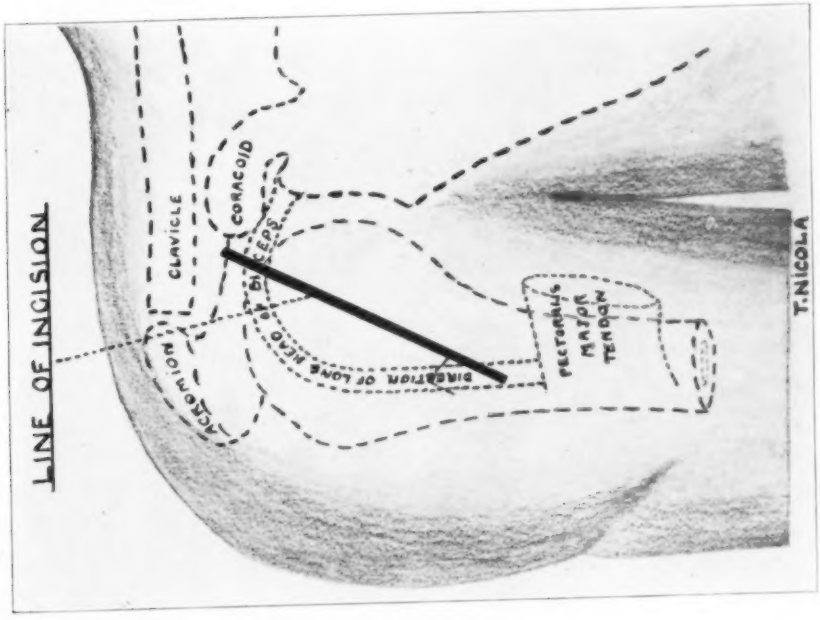

LINE OF INCISION
ACROMION
CLAVICLE
CORACOID
T.NICOLA

FIG. 1

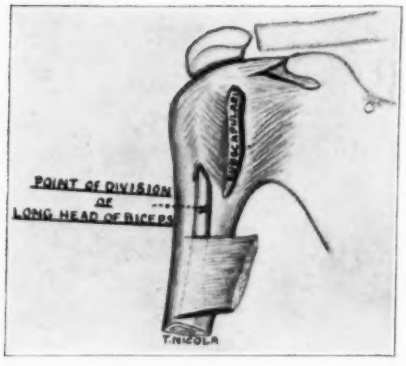


FIG. 3

joint by dividing the transverse humeral ligament, which holds the tendon in the bicipital groove, and by splitting the capsule in the line of the fibers continuous with the transverse humeral ligament. In this step of the operation cutting of the tendon may be avoided by not closing the blades of the scissors while splitting the capsule (Figs. 2, 3, and 4).

4. The tendon of the long head of the biceps is divided about one inch below the cut margin of the transverse humeral ligament, after stay sutures of black silk have been placed in the proximal and distal parts. If this is not done, the distal part will disappear under the tendon of the pectoralis major muscle, thereby prolonging the operation (Fig. 5). The elbow is flexed at about forty-five degrees during this step and throughout the rest of the operation. The synovial covering of the tendon should be removed without fail, so that it becomes fixed in the tunnel in the head of the humerus through which it is later passed.

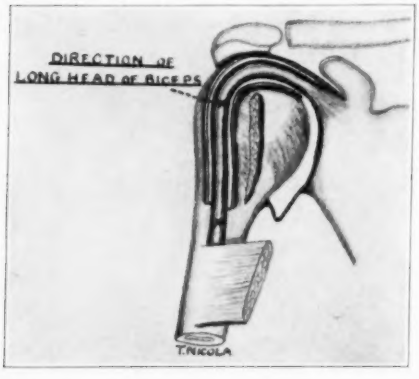


FIG. 4

5. By means of a quarter-inch drill or, better, a quarter-inch gouge (Fig. 5), a hole is then made through the head of the humerus, beginning in the bicipital groove about one inch distal to the lesser tuberosity. This gouge should be so directed that it comes out on the articular head of the humerus in the line of the direction of the tendon, from one-half to three-quarters of an inch from the edge of the articular cartilage. If it comes out less than half an inch from the edge of the articular cartilage, there is a chance for recurrence of the dislocation, because the tendon will not check the arm in extreme abduction. If fixed in the bicipital groove, the tendon will not check the arm until it reaches from 255 to 280 degrees of abduction. This amount of abduction cannot be reached without dislocating the shoulder. The maximum of abduction of a normal shoulder is ninety degrees, and, combined with the scapular movement, the abduction of the shoulder reaches a maximum of 180 degrees.

6. The gouge is then withdrawn and the loose bone marrow is removed from its cavity. The gouge is reinserted and a flexible probe

is passed through the tunnel from the proximal end, guided by the gouge. The probe is then threaded with the black silk which is attached to the proximal part of the divided tendon. The tendon is then drawn through the tunnel and united to the distal part by means of the black silk which was passed through the tendon before it was divided (Figs. 5 and 6).

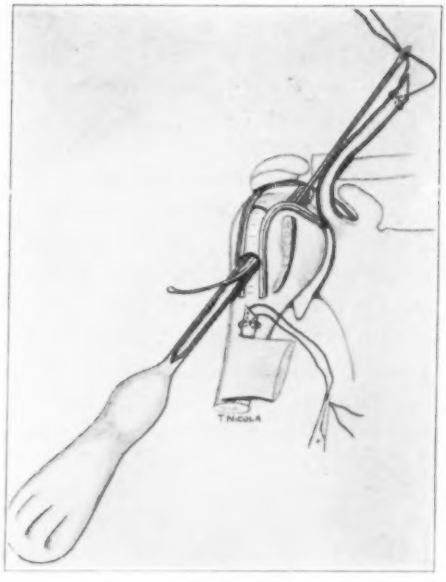


FIG. 5

7. The arm is abducted to a right angle and the transverse humeral ligament is sutured to that part of the tendon of the long head of the biceps which lies in the bicipital groove. This does two things: (1) it insures enough tendon from the head of the humerus to the glenoid cavity, thus removing any restriction of normal abduction; and (2) it holds the tendon from moving up and down in the tunnel, and hastens its fixation in the tunnel.

FIG. 6

8. The transverse humeral ligament and the capsule are sewed with continuous No. 1 plain catgut sutures; the split deltoid muscle, with a few interrupted sutures. In women the skin is closed with skin clips or a subcuticular stitch.

9. The shoulder is then put up in a simple Velpeau bandage reinforced with adhesive plaster, with the arm close to the chest and the elbow flexed to forty-five degrees. This position is maintained for two weeks. In epileptics it is wise to keep the shoulder immobilized for at least six weeks. If the operator chooses, the shoulder may be put up in the abducted position of ninety degrees, using a plaster-of-Paris shoulder spica bandage. In twenty-seven consecutive cases operated upon by the author, the simple Velpeau bandage was used with excellent results.

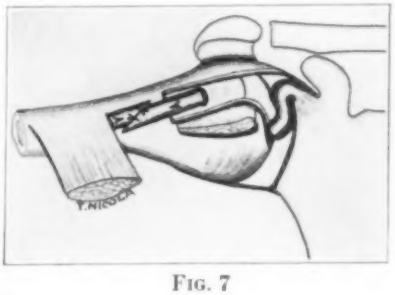


FIG. 7

10. The after-care may include radiant heat, massage, and active movement, with the arm carried in a sling between treatments. In nine of the twenty-seven cases, no physical

therapy treatment was used; these patients made excellent recoveries with no prolongation of the convalescent period, which ranged from four to twelve weeks. Three compensation cases made up the twelve-week convalescent period.

Three cases of recurrence of the dislocation have been reported to the author by various surgeons who have used this operation. In two of these cases, the operator reoperated. In one case, the hole in the head of the humerus was too large, allowing the tendon to move up and down in the tunnel, thereby causing it to fray. In the other case, the hole was not placed far enough on the articular surface of the humerus, so as to check the head when the arm reached 180 degrees of abduction. These recurrences were due, therefore, to faulty technique.

To prove that a normal tendon is strong enough to check the head of the humerus from redislocating, experiments on the tensile strength of the live tendon of the long head of the biceps were carried out. Four tendons were tested. The first two were removed from patients upon whom arthrodesis of the shoulder was performed—one, a boy of seventeen; the other, a boy of twelve. The other two tendons were removed four hours after death from two men who had been killed in automobile accidents.

Specimen 1*. Boy, aged seventeen years. Four inches of tendon of the long head of the biceps was removed for examination. The specimen was kept in normal saline for two hours before examination.

Dimensions of section—	.125 by .199
Area in square inches—	.02485
Maximum load in pounds (actual)—	210
Tensile strength—	6,910 pounds per square inch
Load in pounds—	0–10 –20 –30 –40 –50 –60 –70 –80
Percentage of elongation—	0–1.08–2.16–3.22–4.3–4.3–4.3–5.37–5.37

Specimen 2*. Boy, aged twelve years. Four and one-half inches of tendon of the long head of the biceps was removed for examination. The specimen was kept in normal saline for five hours before examination.

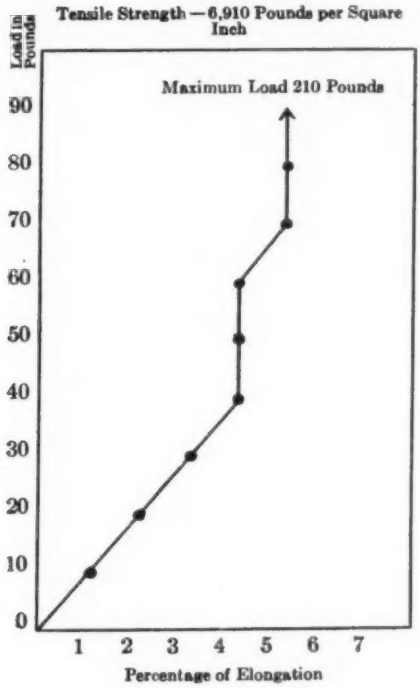
Dimensions of section—	.131 by .124
Area in square inches—	.01624
Maximum load in pounds (actual)—	179
Tensile strength—	7,810 pounds per square inch
Load in pounds—	0–10 –20 –30 –40 –50 –60 –70 –80 –90
Percentage of elongation—	0–1.03–1.8–2.1–2.1–3.1–3.9–4.4–5.1–5.1

Specimen 3*. Man, aged twenty-nine years. Four inches of tendon of the long head of the biceps was removed for examination. The specimen was removed four hours after death and examined three hours later.

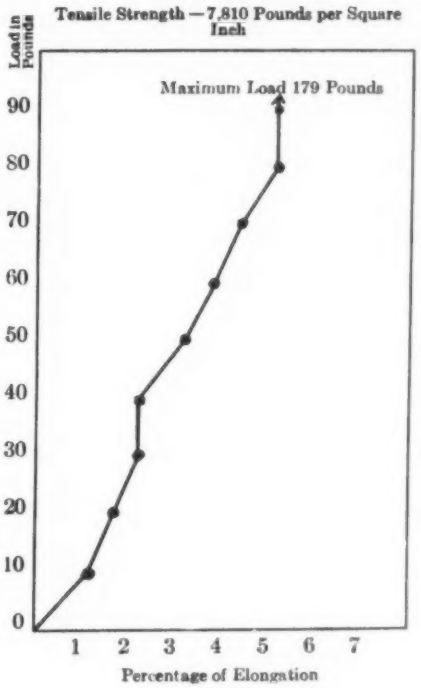
Dimensions of section—	.2 by .194
Area in square inches—	.0388
Maximum load in pounds (actual)—	278
Tensile strength—	7,360 pounds per square inch
Load in pounds—	0–10 –20 –30 –40 –50 –60 –70 –80 –90
Percentage of elongation—	0–1.07–1.9–3.06–3.2–4.4–5.1–5.4–5.4–5.4

* Tests made by New York Testing Laboratories, G. Horowitz, Engineer.

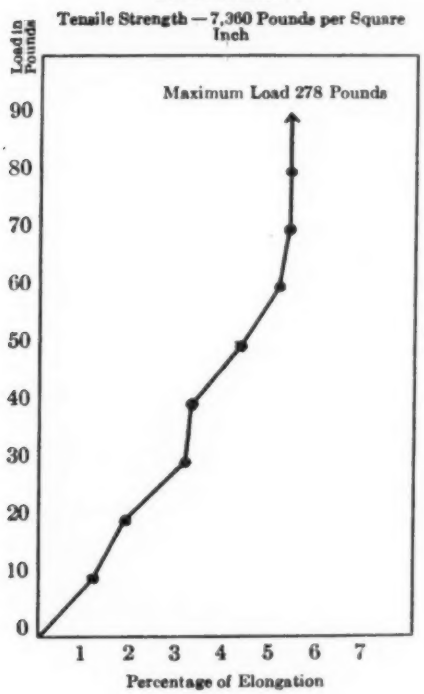
SPECIMEN 1



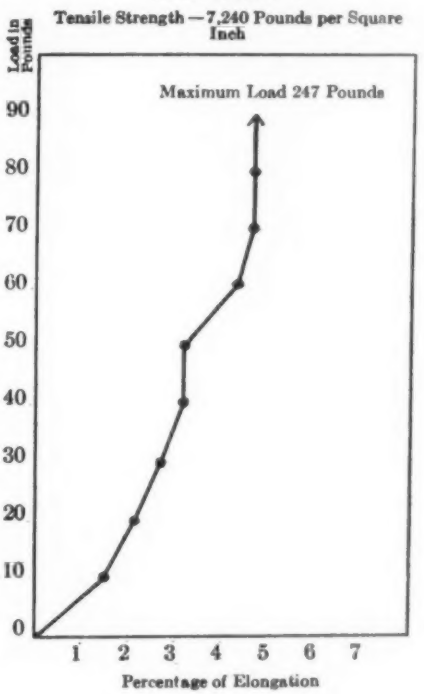
SPECIMEN 2



SPECIMEN 3



SPECIMEN 4



Specimen 4*. Man, aged forty-five years. Four inches of tendon of the long head of the biceps was removed for examination four hours after death due to trauma. The specimen was kept in normal saline for two hours before examination.

Dimensions of section—	.214 by .191
Area in square inches—	.04087
Maximum load in pounds (actual)—	247
Tensile strength—	7,240 pounds per square inch
Load in pounds—	0–10 –20 –30 –40 –50 –60 –70 –80 –90
Percentage of elongation—	0–1.6–2.13–2.8–3.1–3.1–4.2–4.7–4.7–4.7

SUMMARY

1. The operation is simple.

2. It can be used in all cases, whether the pathology be bony, capsular, or muscular.

3. There is practically no restriction of motion of the shoulder.

4. Convalescence is short.

5. Tensile strength of tendon of the long head of the biceps varies from 6,910 to 7,810 pounds per square inch.

6. The maximum load in pounds (actual) for the tendon of the long head of the biceps varies from 179 to 276 pounds.

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*Tests made by New York Testing Laboratories, G. Horowitz, Engineer.

KNEE-JOINT VISUALIZATION

A Roentgenographic Study with Iopax

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A clinical roentgenographic study was begun early in 1932 in the Arthritis Clinic of the Northwestern University Medical School, using iopax solution in the knee joint in an attempt to learn its value and limitations for visualization of the synovial pouches of this joint. While relatively few joints have been studied, we have seen no unfavorable reactions; the roentgenograms have suggested clearer diagnoses; and we have noted some unexpected therapeutic benefit in several instances.

Iopax seemed to offer an easily handled solution which overcame some of the definite objections to fluids previously used [1]. Iopax, readily soluble in water, rapidly mixed with the watery fluids present in the joints. Its pressure was more easily controlled at all stages; and its removal was more completely accomplished than that of the oily fluids. It was well known that this material was rapidly excreted by the kidneys and that it gave good contrast shadows. The ease and safety with which arteries had been visualized by Dr. Geza de Takats [2] suggested the use of this substance in the knee joint.

Iopax was used in a similar study in the Clinic of Michaëlis in Germany, reported in 1931 [3]. His study was a diagnostic one, made of patients with a persistent effusion. There were no serious reactions, except that some bleeding occurred in those joints which had suffered recent trauma. Michaëlis noted that the solution was rapidly absorbed; the shadow greatly diminished in one hour, and in three to five hours no shadow remained in or about the joint. He did not aspirate the drug because of this rapid absorption. His technique was much the same as that used in our Clinic, with this important difference,—that his patients were kept in bed under observation for one or two days. Table I shows some details of his group of cases.

METHOD

All patients studied in our Clinic were ambulatory,—clinic or private patients. They were taken directly to the x-ray table without previous preparation. Here the injections were made with surgical aseptic technique. The solution used was an autoclaved thirty per cent. iopax, dissolved in five-tenths per cent. novocain. Injection was made directly into the suprapatellar pouch, from the lateral aspect of the joint at the level of the superior border of the patella.

TABLE I

FROM STUDY OF MICHAËLIS (*Röntgenpraxis* III, 320, 1931).

Case No.	Age Sex	Diagnosis and Etiology	Puncture Fluid	Iopax Injection	Reaction
1	38 Male	Arthritis, 3 years. Unknown etiology. Culture pneumococcus.	120 c. c., turbid, serous.	40 c. c.	None.
2	13 Male	Hemarthrosis, recent trauma.	80 c. c., blood.	40 c. c.	Immediate pain, hemorrhage.
3	48 Male	Chronic arthritis. Cultures sterile.	50 c. c., turbid, serous.	40 c. c.	Temperature of 102 for 24 hours.
4	10 Male	Congenital lues. Wassermann +++, Tuberculin 0.	60 c. c., serous.	40 c. c.	None.
5	60 Male	Tuberculosis of knee joint. Culture positive for tubercle bacillus.	100 c. c., turbid, serous.	40 c. c.	None.
6	26 Male	Trauma, 3 weeks. Culture sterile.	80 c. c., turbid, serous.	50 c. c.	Ambulatory. None.
7	38 Male	Effusion of knee. Etiology unknown. Cultures sterile.	50 c. c., clear.	40 c. c.	None.
8	60 Female	Tabetic arthropathy.	150 c. c., clear.	80 c. c.	None.
9	19 Female	Effusion of knee. Etiology unknown.	60 c. c., clear.	40 c. c.	None. Ambulatory.
10	45 Male	Fracture of patella, 3 weeks.	40 c. c., bloody fluid.	30 c. c.	Burning pain, 15 minutes.
11	54 Female	? Ganglion. Cultures sterile.	50 c. c., clear.	40 c. c.	None.
12	20 Male	Trauma, 2 years before. Cultures sterile.	80 c. c., serous.	60 c. c.	Burning for half hour; discomfort for 48 hours.

The joints with effusion were first aspirated; as much of the fluid as possible was removed, and this was replaced with the iopax solution. Roentgenograms were taken in both planes. Then the leg was manipulated through as full a range as possible, and second films were made with the leg in flexion. Only in this way could distribution of the fluid to the posterior pouch be obtained.

In joints without effusion salt solution was first injected; this was withdrawn to make certain of the needle position, and then the iopax solution was injected. Complete distribution necessitated some distention of the synovial sac, which caused discomfort. In some of the

TABLE II

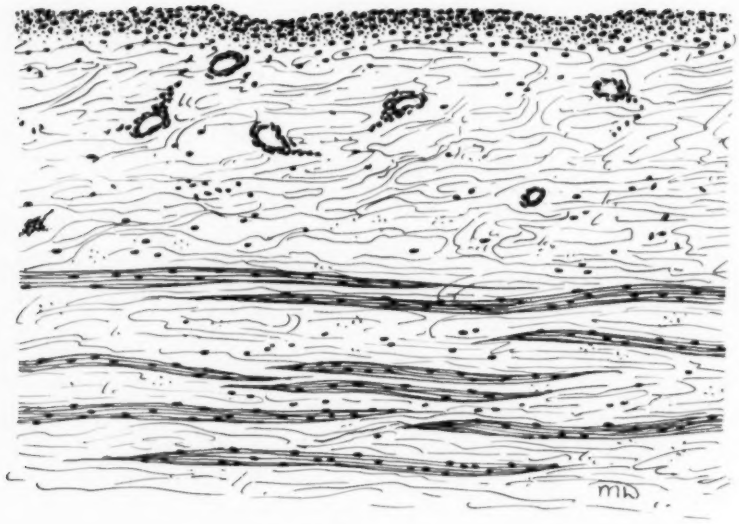
CASES STUDIED AT ARTHRITIS CLINIC, NORTHWESTERN UNIVERSITY MEDICAL SCHOOL

Case No.	Age Sex	Diagnosis and Etiology	Fluid Removed	Iopax Injection	Reaction	Remarks
1	29 Female	Villous synovitis. Etiology unknown.	None.	20 c. c.	Local pain, 48 hours. No fever.	Pain rapidly subsided. No permanent effects.
2	61 Female	Hypertrophic arthritis. Etiology ?	None.	35 c. c.	Severe pain, 48 hours.	Freedom from pain for 2 months after injection, the longest period she had been comfortable.
3	50 Male	Charcot joint. Syphilis.	None.	40 c. c.	None.	No effects noted.
4	28 Male	Infectious arthritis. Culture, no growth.	40 c. c., turbid, yellow.	35 c. c.	Immediate burning pain, lasted 48 hours.	Effusion did not return. Freedom from pain for 5½ months.
5	32 Male	Synovitis. Popliteal bursitis. Culture, no growth.	6 c. c., lime colored, turbid fluid.	28 c. c.	None.	No change. Fluid in knee joint and ganglion returned.
6	33 Male	Infectious arthritis. Culture, no growth.	25 c. c., turbid, yellow.	22 c. c.	Slight discomfort, 24 hours.	Relief from pain for 2 weeks. Pain and fluid reappeared, then gradually disappeared. No symptoms for past 10 months.
7	36 Female	Infectious arthritis. Culture sterile.	34 c. c., turbid, yellow.	22 c. c.	Very little discomfort.	Some relief of pain for 4 weeks.

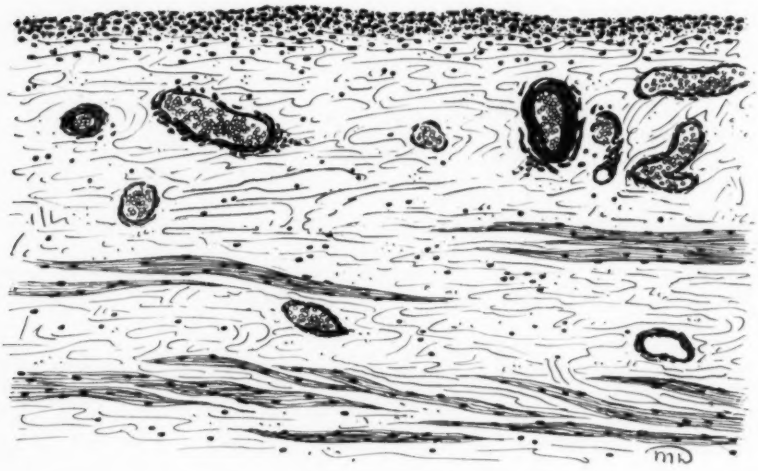
patients, after the roentgenograms had been taken, as much of the solution as possible was withdrawn, but there was no noticeable effect on the discomfort.

A sterile dressing was placed over the puncture site with a snug elastic bandage over the joint. Patients were advised to remain quiet in bed at home for a period of forty-eight hours, and to apply heat to the area of the joint.

In these patients from twenty to forty cubic centimeters of the solution was used, depending on the amount of distention and pain produced. In the later injections relatively less solution was used, and yet the shadows in the roentgenograms seemed to be equally clear. For the average



A



B

FIG. 1

Photomicrographs of sections from dogs' joints, showing: in *A* the appearance of the synovia and subsynovial tissues from an uninjected joint, and in *B* similar tissue from an injected joint. *B* shows the engorgement of the subsynovial blood vessels five days after injection, but no cellular exudate.

knee approximately twenty-five to thirty-five cubic centimeters is sufficient and is well within the safe limit. More than two ounces (60 cubic centimeters) should not be used, for the distention grows relatively more dangerous as 100 cubic centimeters is approached. As was pointed out

by Colp and Klingenstein [4], rupture of the suprapatellar or postcondylar pouches will usually occur on injection of 100 cubic centimeters of fluid.

EXPERIMENTAL STUDY

To make sure that the solution would not produce too much chemical irritation, a study was first made of synovial tissue obtained from the knee joints of two dogs injected with iopax solution. The uninjected joints were used for controls.

The technique here described was followed. The dogs were anaesthetized with ether; the area about the knee was shaved and prepared with iodine-alcohol. The joint cavity was easily entered by directing a medium-sized, short-bevel needle beneath the patella. Synovial fluid was seen to drop from the needle before injection was done. Iopax solution was then injected to produce a moderate symmetrical distention of the joint capsule. The dogs were then allowed to recover. No dressings were used and there appeared to be no leakage from the puncture wounds.

Examination of the joint tissues from Dog A, sacrificed on the fifth day, showed the cartilage of both joints to be smooth, creamy white, and glistening. A few drops of clear synovial fluid were noted in each. No gross difference was seen between the control and the injected joints.

Dog B had no local swelling at any time; he was sacrificed on the sixth day. Gross examination of the injected knee joint showed injection of the small blood vessels on the anterior aspect of the synovial lining beneath the patella. Only two or three drops of clear synovial fluid were seen. The synovia was smooth, glistening, creamy white in color, except as noted. Several blocks were cut from both the control and the injected joints for microscopic study. The controls showed uniformly a normal layer of mesothelium, overlaying a membrane propria rather rich in blood vessels. Beneath this, in various areas, was found either fat, or striated muscle, or heavy fibrous tissue. The injected joints showed pictures similar to the controls, the only change being a moderate tendency to dilatation of blood vessels, but without cellular exudation. Figure I shows drawings of the microscopic findings.

CASE STUDIES

The first injection was done on a woman (L. C.), of twenty-nine years, who complained of crackling in the knee joints of one year's duration. No other joints were involved. There was no history of trauma, no effusion, no locking of the joint, and no loss of function. Examination revealed some generalized thickening about both knees, with a loud crepitus on motion. This was made louder on weight-bearing motion. Roentgenograms of the knees were reported to show no disease. We tried to inject twenty cubic centimeters of a thirty per cent. iopax solution into her right knee. Roentgenograms showed that the solution was outside the knee cavity, extending upward in the fascial planes of the upper leg, just lateral to the suprapatellar pouch. There was local pain in this area for about forty-eight hours, when the pain subsided, and it has not returned. No reaction occurred in the periarticular tissues.

FIG. 2

Case 5. Roentgenogram of injected popliteal bursa, taken immediately after injection.

This faulty injection proved that the solution would do no actual harm, even when injected into the tissue spaces.

The second patient, a woman of sixty-one years, had a hypertrophic arthritis of both knees, with considerable pain and recurring effusion in the left knee, which was moderately swollen. Plain roentgenograms showed some spur formation, but no change in the articular surfaces. No fluid was removed from this knee; thirty-five cubic centimeters of a thirty per cent. iopax solution was injected into the suprapatellar pouch. Roentgenograms made immediately showed definite irregularity of the synovial outline with a diagonal division of negative shadow running across the suprapatellar pouch. The woman complained of rather more severe pain in this knee for forty-eight hours, and then, strangely enough, was completely free from any pain in this knee for sixty days. This was the longest period of freedom from pain she could recall in recent years. The other knee continued to pain her during this time.

The third patient, a man of fifty years, with known lues, was chosen because he had a Charcot knee joint. An attempt was made to gain a clearer picture of the changes in the knee capsule in its obvious pathological state. We did not gain a good outline of this joint space, but we were able to localize several rounded, calcified, loose bodies definitely within the joint. These appeared as areas of increased density, with a halo shadow of decreased density about them. This patient, as was expected, suffered no discomfort, either at the time of the injection or later.

In an earlier Charcot joint, a much clearer definition should be obtained, and would, perhaps, be of differential diagnostic value.

The fourth patient, a young man of twenty-eight years, complained of a swollen, painful right knee. This swelling and pain had appeared one week before, without antecedent trauma. The right knee was stiff and particularly painful on weight-bearing, so that the patient had to use a cane in walking. With this there was a limp and failure to flex the knee more than a few degrees. Examination revealed an effusion, and pain on pressure or motion over the area of the semilunar cartilage and attachment of the internal lateral ligaments.

Roentgenograms showed no evidence of disease in the bones or joint. The joint space appeared normal. A diagnosis of acute synovitis of unknown etiology was made and the man was treated by the usual means of strapping, rest, and salicylates for one month. Neither the pain nor the effusion disappeared.

Five weeks after he came under observation, injection was done. First forty cubic centimeters of a turbid, yellow fluid was withdrawn from the joint. Iopax solution was immediately injected to distend the bursa. When thirty-five cubic centimeters had been injected, the patient complained of considerable pain. About five cubic centimeters was withdrawn, with relief, and a roentgenogram was made. The report of Dr. James T. Case on these films stated: "Opaque media has been injected into the bursa of the right knee. We noted an irregularity of the bursa having a jagged appearance. This is seen to the best advantage when just anterior to the knee joint proper. These findings are, I believe, compatible with a hypertrophy or thickening of the bursal lining."

FIG. 3

Case 6. Roentgenogram demonstrating a very irregular suprapatellar pouch. Twenty-two cubic centimeters of iopax solution had been injected.

The injected fluid gave this patient some burning pain in the knee, which disappeared gradually in forty-eight hours. One week later there had been no return of the effusion; the pain was much less severe, and was noted slightly when the knee was twisted. This improvement continued until the patient reported, eight weeks later, that the knee did not pain him; the effusion had not returned. The knee showed a full range of motion at this time. The man was last seen fifteen weeks after injection, was free of pain, walked with a normal gait, and showed no effusion. He felt he no longer needed treatment and would not return to the Clinic again.

The fifth patient, a man of thirty-two years, came complaining of swollen stiff knees of eight years' duration. We found smooth, rounded, tense, fluctuant masses occupying a large part of each popliteal space. These tumors did not pulsate. They were made more prominent and more tense on full extension of the leg; complete flexion was blocked by these masses. They were ganglia.

Plain roentgenograms showed some small spur formation on the posterior edge of the right tibia, but no other evidence of change in the joints.

Two iopax injections were done on one knee in this patient. The first was made into the suprapatellar pouch after removal of some six cubic centimeters of an olive-colored,

FIG. 4

Case 7. Roentgenogram of an irregular, narrowed synovial pouch, taken immediately after twenty-two cubic centimeters of iopax solution had been injected.

FIG. 5

Case 7. Roentgenogram taken two hours after injection. Incomplete absorption has taken place.

viscid, turbid fluid. Approximately twenty-eight cubic centimeters of the iopax solution was then injected. This gave a good visualization of the anterior chambers of the knee, but did not demonstrate any communication with the bursae in the popliteal space. There was no discomfort following this procedure. A week later an injection was made posteriorly directly into the bursa of the same joint. This demonstrated clearly the outline and extent of the bursa, but did not show any communication with the knee joint, as shown in Figure 2.

We felt that this visualization clearly set this bursa apart from the joint proper, and so made surgery appear less hazardous.

The sixth patient was a man, thirty-three years old, who had an infectious arthritis of fifteen months' duration. In the sixth month of his illness he began to have considerable pain in his knee. This joint became swollen, hot, and painful on motion,—particularly motion undertaken after a period of rest. The effusion and stiffness remained and increased; the local heat decreased; weight-bearing and motion remained painful. The soft tissues about this knee became thickened, until the borders of the suprapatellar pouch could be easily outlined by palpation. Medical treatment did not give relief; instead this knee seemed to grow more painful and have less motion as time elapsed. Eight months after the onset of the local involvement, puncture of this knee joint was done and iopax injected. Some twenty-five cubic centimeters of a turbid, yellow fluid was removed, and this was followed immediately by injection of twenty-two cubic centimeters of the iopax solution. There was no immediate pain. Roentgenograms showed a surprisingly irregular synovial pouch, with a scalloped edge, corresponding to the thickening observed by palpation (Fig. 3). This apparently confirmed the diagnosis of hypertrophic synovitis; and the operative removal of this synovia was advised, but operation was refused. Ten weeks after the injection, the patient reported that he was feeling so much better that he had returned to work,—this was after an absence of some fifteen months. He had stopped all treatment. The knee was no longer swollen, the synovial edge could not be palpated. There was a full range of motion; but some protection, on rising from a low chair and in using the stairs, was still evident. He was able to do a full day's work in his garden or in his office in Chicago.

The seventh injection was done into the knee of a woman thirty-six years old. The diagnosis was infectious arthritis, of nine years' duration. The knee was thickened and swollen, with both soft-tissue induration and effusion. Motion was present,—extension, 150 degrees, to flexion, 60 degrees. The roentgenograms (Figs. 4 and 5) show an irregular synovial pouch, with some narrowing in the suprapatellar area, and a large irregular posterior condylar pouch. The second of these films (Fig. 5) was taken two hours after the injection and shows considerable absorption of the opaque solution.

The rapidity of this absorption from a joint so obviously diseased, confirms the statement of Michaëlis that iopax solution is absorbed from the joint in a few hours.

Table II gives a summary of these cases from our Clinic.

COMMENT

It appears significant that seven patients in this group had knee-joint injections without an unfavorable reaction. Even in the first patient, where the injected fluid was placed outside the synovial sac, no more serious discomfort was suffered than by those in whom the injections were more successful. The most serious reaction noted was increased pain for forty-eight hours. No patient had symptoms of fever; none

noted any local redness at the puncture site or joint area. In none of these patients did the pain last longer than seventy-two hours. Surprisingly enough, three of the seven patients had relief from the previous joint pain and effusion for from two months to six months. This was not anticipated, and would not in our opinion justify joint injection unless other more conservative measures had failed.

It is difficult to evaluate the diagnostic value of the reports cited, in view of the difficulties of getting surgical exposures of the joint lining and in obtaining tissues for pathological study.

One should have a larger acquaintance with the x-ray appearance of knees so injected before giving a dogmatic interpretation of the roentgenograms. We believe the method has diagnostic value, particularly in separating the chronic arthritic knee from those joints which might more readily yield to surgical treatment,—namely, the doubtful displaced cartilages, loose bodies, the true hypertrophic synovitis, and erosions of the weight-bearing surfaces of the cartilage. We believe it may also be of value in the diagnosis of early syphilitic and tuberculous joints, as well as in a more complete study of certain old traumatic conditions of the knee. With experience in studying further roentgenograms of such injected joints, we believe we will be able to read more clearly the positive and the negative shadows that give a composite picture of the outline of the synovial sac and the contours of the joint cartilages. We are continuing this study.

SUMMARY

Thirty per cent. iopax, dissolved in a five-tenths per cent. procaine solution was used to visualize knee joints in a small number of cases. This solution did not cause serious reactions and was quickly absorbed from the joints. The method seems safe and, while it has been used only for diagnostic purposes, it may even yield therapeutic results. The solution used produced a hyperaemia of the synovial membrane, but no cellular exudate.

The author wishes to acknowledge with gratitude the valuable suggestions and help of Dr. Geza de Takats and Dr. D. E. Markson. Shering and Gatz were generous in supplying the iopax for this study.

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OSTEOID-TISSUE-FORMING TUMOR SIMULATING ANNULAR SEQUESTRUM*†

BY HENRY MILCH, M.D., F.A.C.S., NEW YORK, N. Y.

In a report appearing in 1930, Hitzrot [1] described an unusual case which he considered "a sclerosing osteomyelitis of the carpal scaphoid", though he was not certain that it should not be considered "a sclerosing type of bone tumor". The patient was a woman who had injured her wrist while changing her automobile tire. The wrist was swollen and painful and on roentgenographic examination showed in the distal half of the left carpal scaphoid, "a ring-like shadow of sclerosed bone with a darker decalcified-appearing central portion. In this darker area is a rounded, very dense piece of bone, about the size and shape of a green pea." At operation the bone was white, sclerotic, and separated from the rest of the bone as by a capsule. The histological section showed "very dense, atypical bone. The lamellae are irregular. Lacunae are present, but small and no marrow cavity is found."

This unusual picture naturally impressed itself on our mind, particularly as to the significance of the roentgenographic appearance of the lesion. This became of special moment, because, in the first case which we had the opportunity of observing, the question of the liability of an insurance company for an alleged injury was raised. As a result of the patient's refusal to submit to operation at that time, the answer to the question had to be deferred; within a relatively short time, three other almost identical cases have presented themselves. Except for the variety of their location, these cases are similar in history, clinical findings, roentgenographic examination, and histological study; and resemble Hitzrot's case in such detail that we believe all should be grouped in the same category.

CASE REPORTS

CASE 1. S. T., male, aged twenty-two years, single, stated that on May 1, 1933, he had struck the outer side of his right radius against a buffing machine. He complained of slight pain, but was able to continue at his work until the last day of the same month, when he noted swelling and redness of the wrist, with so much pain that he was unable to continue with his work. He was treated by another physician, who applied antero-posterior splints, with some relief of pain. When seen on June 26, 1933, there was present a non-fluctuating swelling above the right wrist. There was marked tenderness on pressure over the palmar aspect of the right radial styloid, with slight redness in this area. Motion of the wrist was limited in all directions, but especially in flexion and extension. There appeared to be no involvement of the hand or fingers. The x-ray showed a dark, annular shadow, surrounded by an area of osteoporosis in the lower, outer portion of the right radial styloid, and apparently involving the wrist joint. At that time a diagnosis of bone abscess, with annular sequestration, was made: operation was advised, but this

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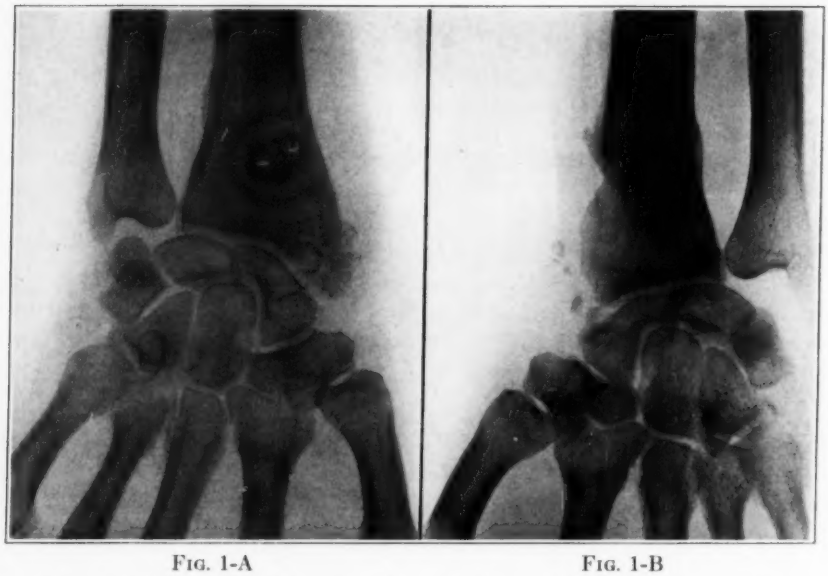

FIG. 1-A

Case 1. Note annular shadow, with reaction about the site of the lesion in the right radius. Roentgenogram taken five months after alleged injury.

FIG. 1-B

Postoperative roentgenogram. Remnants of calcific deposits in soft tissues around site of original lesion.

the patient refused. Subsequently the area of involvement seemed to grow larger and the roentgenogram (Fig. 1-A) showed what appeared to be a definite calcification in the region of the flexor tendons. The pain became worse and finally, in December 1933, the patient was operated on by Dr. Harold M. Rabinowitz, to whom I am indebted for the further details of this case. At operation the lower end of the radius was found markedly thickened by extremely sclerotic bone. The tendons on the anterior aspect of the wrist were involved in this process of ossification. When these were freed and the radius exposed "an encapsulated button of bone was found in the lower end of the radius, involving the articular surface". There was no pus and no evidence of osteomyelitis. (The pathological section examined at another hospital was reported as showing "chronic inflammation".) The patient's wound apparently healed kindly, though at the present time he still has some pain and limitation of motion in the wrist.

CASE 2. A. McC., male, aged twenty-three years, was admitted to the Hospital on June 26, 1933, with a diagnosis of tuberculosis of the left astragalus. The patient observed that he had slipped and hurt his left ankle about four years before. A hematoma, which had developed just anterior to the internal malleolus, had cleared up within several days and the patient had had no symptoms until two years later, when he again began to complain of stiffness, tenderness, and a sense of fatigue in the left ankle. This fatigue he described as "a feeling that the sinews were being cut in the leg". This apparently became worse on exertion and he had a constant limp, though it did not increase markedly. Three months previous to admission he had been seen by an osteopath, who had stretched the ankle several times, and since that time the pain had become more marked, the ankle had become swollen, and the stiffness and limp had increased.

Examination disclosed a swelling of the anteromedial aspect of the left ankle joint, just in front of the internal malleolus. This mass was about an inch and a half in diameter, tense, and slightly fluctuating. There was no redness or local heat, but there was marked tenderness on pressure. All motions of the ankle were painless and similar to those of the right leg, except for slight limitation of dorsal extension. The quantitative

tuberculin test was negative; the blood count was normal; the Wassermann was negative. The roentgenogram (Fig. 2) showed a cup-shaped area of osteoporosis at the superior surface of the junction of the head and neck of the astragalus. In the center of this area there was a sclerotic, rounded area of bone, suggesting a sequestrum.

On June 29, 1933, operation was performed through a three-inch anterior incision, extending distally from the ankle joint. On retracting the wound, the tissues over the astragalus were found very oedematous and the bone irregular. The cartilage overlying the diseased area was loose. The localized area of diseased bone was about one and one-half centimeters in diameter and extended into the neck of the astragalus. The attempt to remove this by means of a curet was unavailing, so that the whole mass had to be gouged out with an osteotome. Cultures were taken, the cavity was packed, and a plaster-of-Paris cast applied. Smears and guinea-pig inoculation from the tissue removed at operation were reported negative for tuberculosis.

The pathological report by Dr. Jaffe showed "a tumor process characterized by the formation of large amounts of osteoid and fibrous bone. The circular fragment shows considerable induration of the tumor bone peripherally. *Diagnosis:* Osteoid-tissue-forming tumor of the astragalus (benign)." Since operation the wound has healed completely and x-ray shows no evidence of recurrence at the present time. The patient, however, still complains of slight pain, especially on weight-bearing. This may, of course, be due to the operative trauma rather than to the presence of bone tumor.

CASE 3. S. L., male, aged fifteen, was admitted to the Hospital on May 8, 1933, with a complaint of pain in the lower external aspect of the left leg of two months' duration. There was no previous history of acute infection or recent trauma. The pain, of a dull, boring character, began gradually and had increased so that it interfered with sleep.

Examination disclosed a swelling of the lower left leg, extending from the tip of the external malleolus upward for a distance of about three inches. There was no fluctuation or redness, but there was slight increase in the surface temperature. The ankle joint showed no limitation of motion whatsoever. The Wassermann test was negative, the tuberculin test moderately positive in high dilution. The roentgenogram (Fig. 3), re-

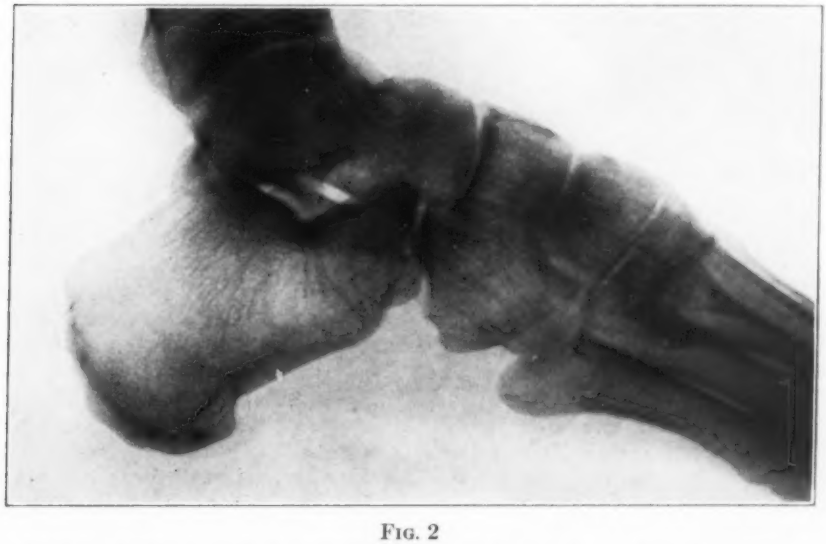

FIG. 2

Case 2. Lesion in neck of astragalus four years after injury. Note radio-opaque zone of demarcation not seen in Figs. 1-A and 1-B.

ported by Dr. Pomeranz, showed "in the medulla of the fibula, approximately one inch above the epiphyseal line, a vacuolated area. The margins of this area are clean cut. There is a slight endosteal sclerosis, with distinct cortical and periosteal thickening. The periosteal thickening is deposited in layers parallel to the long axis of the shaft. The posterior surface of the fibula at approximately the same level also shows a parallel periostitis. The ankle joint proper is roentgenographically negative. *Conclusion:* Bone abscess, lower end of the fibula."

In the belief that we were dealing with a Brodie's abscess, the bone was exposed and several drill holes were made through the cortex for drainage. The wound was packed and a plaster-of-Paris bandage was applied. Within two weeks the patient was discharged to the Out-Patient Department. In spite of the fact that there was no question of pressure, the patient complained of severe pain. In June the patient was readmitted for examination of the so called osteomyelitis, and specimens removed at this time were reported by Dr. Jaffe as showing "osteoid masses in tumor formation. The lesion is entirely benign. *Diagnosis:* Benign osteoid-tissue-forming tumor."

FIG. 3

Case 3. Tumor of fibula taken upon admission for reoperation.

CASE 4. L. H., female, aged twenty, was admitted to the Hospital on December 4, 1933, with a history of pain and swelling in the terminal phalanx of the third toe of about one year's duration. There was no history of injury or of any acute infection. The pain was constant, dull, and boring in character; was worse during the night; was unaffected by exertion; and did not radiate. About two months before, the pain and swelling of the toe had become so severe that the patient was unable to sleep.

Examination disclosed a marked swelling of the distal phalanx of the third right toe (Fig. 4-A). There was no redness or discoloration of the toe, but the nail was discolored brown. There was marked tenderness on pressure over the terminal phalanx. The Wassermann was reported as negative. The roentgenogram (Fig. 4) showed what was reported as a sequestrum of the terminal phalanx of the third toe and a slight osteitis of the terminal phalanx, with a soft-tissue swelling.

Under local anaesthesia a horseshoe incision was made around the tip of the toe and the terminal phalanx exposed. To our great surprise no evidence of osteomyelitis was

found; but, at the tip of the phalanx, in the region where the annular sequestrum had been expected, there was a circular area of white, irregular bone, separated by a slight sulcus from the rest of the phalanx. The terminal half of the phalanx, including the involved area, was resected and submitted for pathological report. The healing was uneventful. The pathological specimen reported by Dr. Jaffe was as follows:

"*Gross:* Specimen consists of a fragment of bone. It was cut longitudinally. It shows a yellowish focus of changed bone. *Microscopic:* Section of the terminal phalanx shows a rather circumscribed focus of irregularly meshed bone, derived through rapid calcification of osteoid. This focus is sharply delimited from the rest of the original bone. The original bone shows a moderate hyperostosis on a reactive basis. The intertrabecular marrow is fiber marrow. There is periosteal new bone formation. *Diagnosis:* Medullary osteoid-tissue-forming tumor."

In all five of the cases here reviewed the clinical picture is characterized by a triad of signs which seem to be pathognomonic of the condition. These are pain, swelling, and the roentgenographic appearance of the involved bone. The pain, of a dull, boring character, is constant, and is worse at night and after exertion. The swelling is localized to the affected area and may or may not be associated with heat and redness of the overlying skin. These signs might well be present in other affections, and so may condone the erroneous diagnosis of Brodie's abscess, tu-

FIG. 4-A

FIG. 4-B

Case 4. Note swelling of toe and discoloration of nail. The central zone is uniformly dense as compared with the central zone in Figs. 1 and 2.

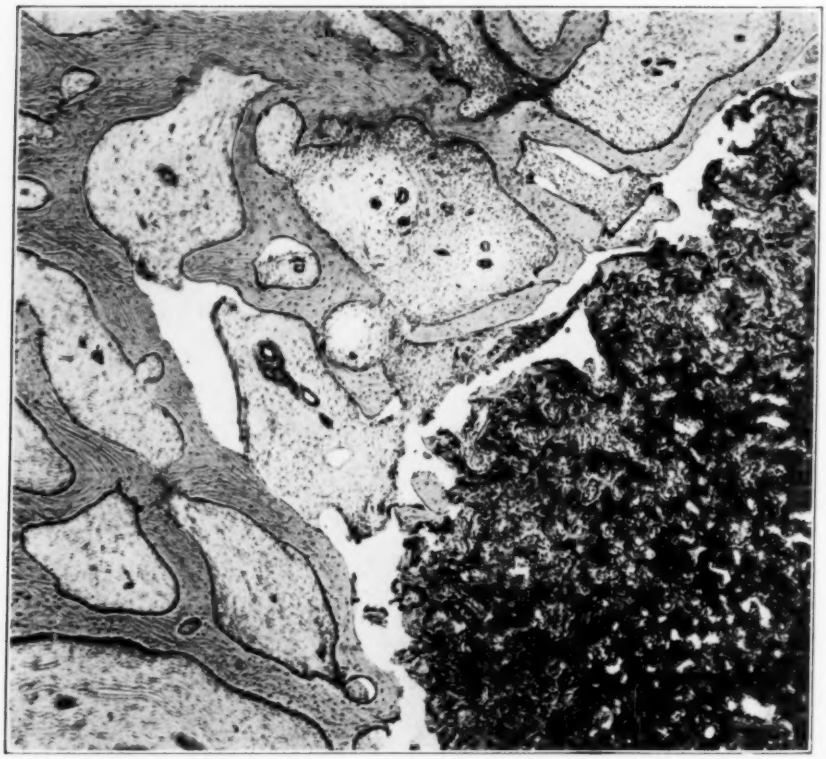

FIG. 5

Case 4. Photomicrograph showing central area of calcifying osteoid tissue, sharply demarcated from surrounding bone to which it is connected by strands of osteoid tissue. Note also reactive hyperostosis in surrounding bone, with fibrous infiltration of marrow spaces. (× 25)

berculosis, or a sclerosing osteomyelitis, previously made. But in the light of our present knowledge, the possibility of any of these conditions can be almost positively excluded upon the basis of the roentgenogram alone, which is so typical that in itself it may be considered diagnostic of the osteoblastic or osteoid-tissue-forming tumor.

At first glance the appearance is similar to that of an annular or button-like sequestrum lying free in a cavity. Closer attention, however, is rewarded by the observation that there are several different parts to be considered. In the earlier stages of the condition, as observed in Case 4, and in the series of roentgenograms in Case 1, the central area is quite uniformly dense. As the lesion ages, this central portion seems to become subdivided into a peripheral annular zone of radio-opacity, surrounding a central lighter area which may represent the site of tumor necrosis. Beyond the central area there is a zone of radio-translucency, which is transversed by radially arranged opaque striations, which seem to unite the central area with the surrounding bone. This is the bone of osteoid tissue which, being calcium-poor, naturally offers but slight barrier to the

passage of the x-rays. Still more peripherally lies the normal bone which may be faintly outlined or which, as in Case 2, may be sharply demarcated from the zone of osteoid tissue by a dense circular shadow. At the outset, the lesion is localized definitely to the involved bone. As time goes on, the surrounding tissues seem to be involved in the reactive process. In Case 1, where redness and heat as well as swelling were noted, this process consisted of the deposition of newly formed, calcium-containing tissue, as well as of the infiltration of the flexor tendons.

In an earlier paper, Jaffe and Mayer [2] observed a tumor of a metacarpal bone, which they reported under the descriptive title of "Osteoblastic Osteoid Tissue-Forming Tumor". Somewhat earlier Bergstrand [3] had described two cases in which the histological appearance of the lesion was in all respects comparable to that observed by Jaffe and Mayer. (Dr. Jaffe exchanged slides with Dr. Bergstrand and they agreed on the similarity of the microscopic pictures.) According to Dr. Jaffe, slides prepared from tissue removed from Cases 2, 3, and 4 histologically resembled those from the metacarpal tumor. On the other hand, there were certain clinical differences between the earlier case and these which should be noted. The metacarpal tumor described appeared to be a very expansile and much more destructive tumor than those in the cases here reported. There appeared to be relatively slight pain associated with the growth of that tumor as compared with these and the x-ray picture, which is here quite characteristic, is not seen even in the earliest roentgenogram of the metacarpal tumor. It may very well be that these two pictures represent different clinical phases of the same pathological entity. On this point we do not feel justified in expressing any definite opinion, especially since the question of the entity and pathological nature of these tumors is at present engaging the attention of Dr. Jaffe.

From a medicolegal point of view, this condition presents another aspect of interest. Three of the cases here discussed gave a history of some sort of injury, usually a blow, antedating the onset of symptoms. If the injury were to be considered as etiologically related to the tumor formation, it could be expected that, with the lapse of time, a difference in the size or shape of the tumor would occur. In Case 1, where roentgenograms were made within six weeks of the alleged injury, there was no appreciable variation in the visualization of the annular shadow as compared with roentgenograms taken four months later, even though the rapid appearance of calcium-containing tissues about the original lesion indicated fairly active growth. On the other hand, in Case 2, where injury had taken place four years before the onset of symptoms, only very slight reaction is noted. It is our opinion that the injury is not to be related to the development of the tumor. At the most it may be admitted that the blow may have served to direct attention to minimal symptoms,—may indeed have accentuated symptoms, or even have been responsible for the initiation of the reactive process; but beyond this any contention would be extremely tenuous.

When we were under misapprehension as to the correct diagnosis, incision and drainage as for a localized osteomyelitis was justifiable. Since the true nature of the condition has been recognized, it must be realized that the only hope for cure lies in the complete eradication of the tumor and closure of the wound without drainage. Failure to proceed in this manner, as in Case 3, necessitated reoperation. The necessity for removal of the tumor becomes more urgent when it is recalled that the metacarpal tumor described by Jaffe and Mayer began to grow rapidly after some years. The possibility of malignant transformation exists, though it is not clearly established.

SUMMARY

A group of cases is presented in which diagnosis has not previously been made correctly. This condition is characterized by pain, swelling, and an unusual x-ray picture. The lesion appears to belong in the class of benign osteoblastic osteoid-tissue-forming tumors and should be treated by complete excision.

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OSTEITIS FIBROSA LOCALISATA OF THE PATELLA

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Lesions of the patella, exclusive of congenital deformities and those directly resulting from injury, are comparatively rare. Undoubtedly the rarest of patellar lesions is that clinical pathological complex spoken of as osteitis fibrosa localisata, of which only two recognized cases have been reported,—the first that of Cole [1] in 1925, and the second that of Faltin [2] in 1928.

We wish to record the third case.

A colored boy, sixteen years of age, gave a history of severe trauma to the right knee two years previous to examination. During the past nine months he had noticed some pain and definite limitation of motion of the right leg.

Examination revealed a markedly enlarged patella. No tenderness was present, but there was an associated lack of development of the muscles of the affected limb. Chemical examination showed the calcium and phosphorus levels and ratios of the blood to be within normal limits. The Wassermann reaction was negative. Roentgenographic examination revealed an irregularly shaped area of opacity in an expanded thin-walled patella, and a tentative diagnosis of giant-cell tumor was made. Further examination showed ununited epiphyses, indicative of youth, but no further cystic bone lesions were found. The patella was removed at operation.

The bone was enlarged and slightly irregular in shape. Sectioning showed a cavernous structure containing a brownish-red fluid with numerous trabeculae coursing through the hollowed medulla. These trabeculae consisted mainly of fibrous tissue, but here and there spicules of bone were noted. On the cortical surfaces there was a definite membrane which could be stripped away. Microscopic examination revealed the true nature of the lesion: there was a fibrous layer lining the cavity, and upon this membrane there occurred embryonic fibroblasts and true calcified bone spicules irregularly scattered. Areas of fresh and old hemorrhage were present. Fibrous bands intertwined and ramified throughout the cavity; occasional giant cells with from three to five nuclei were seen, especially in the areas showing the youngest fibroblastic tissue and fresh hemorrhage. Pigmentation, although present, was not significant.

DISCUSSION

The differential diagnosis between a solitary bone cyst (fibrosa cystica localisata), such as that just described, and a giant-cell tumor depends upon an understanding of certain clinical and pathological features of the two conditions. Over eighty per cent. of cases of osteitis fibrosa localisata occur in persons under twenty years of age, and involve the metaphyseal junction of the growing bone. It is our belief that the lesion has definite and direct connection with that transitory stage in true bone formation in which osteoblastic-osteoclastic activity is especially marked. Maximow [3] states that it is almost certain that osteoclasts produce a lytic ferment, for, where they come in contact with the surfaces of bone lamellae, the cells of

FIG. 1

Drawing of the patella showing enlargement and irregularity.

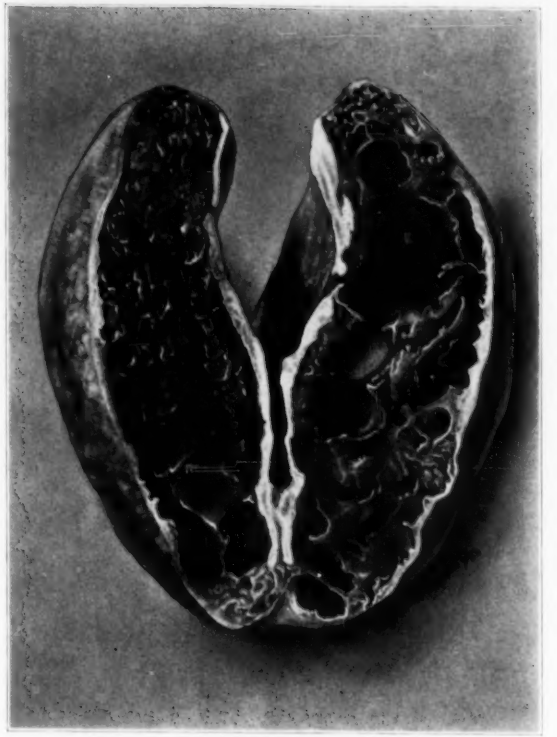

FIG. 2

Sagittal section through patella showing cavernous structure with numerous bone spicules.

the latter dissolve. Normally, ill understood natural forces keep in balance such potentially destructive processes. However, normal inhibiting influences are often hindered in a localized area either by toxins or by altered vascularity, frequently related to trauma. It is under these conditions that osteoclastic activity may result in cavity formation.

We do not agree with Virchow's original view-point that these cysts arise in degenerating chondromata. It is noteworthy in this respect that all case reports and pathological discussions of osteitis fibrosa stress the absence of cartilage. Later views, such as Bloodgood's [4], that low-grade infections are the basic cause, although possibly correct, have never been definitely proved, for, as in our case, cultures and animal inoculations have been uniformly negative. The attempts of some authors to correlate the localized cystic bone conditions, in some of their essential details, with diffuse fibrocystic disease of bone (von Recklinghausen), other parathyroid disturbances, and disorders of calcium-phosphorus metabolism in general hardly seem plausible. Repeated reports in cases of solitary bone cysts show normal blood calcium-phosphorus contents and ratios, and in only one instance in the literature have we found a solitary bone cyst followed in later life by other lesions far removed from the original lesion.

FIG. 3

Roentgenogram showing vacuolated expanded patella. Bony trabeculation is clearly shown.

Microscopic sections prepared from material secured in cases of any type of osteitis fibrosa show the reparative stage which is no different in essential details from any healing or protective reaction within bone. In every case a few scattered giant cells may be seen which at least closely resemble osteoblasts. As Geschickter and Copeland [5] point out, the persistence of the cyst in spite of the healing reaction is the result of nature's difficulty in collapsing its walls, and, when fracture or a crushing procedure at operation aids in bringing about such collapse, the lesion heals.

Giant-cell tumors of the bone occur later in life, when ossification is complete or nearly so. They are found in the epiphyseal regions of the bones and are nearly always located acentrically, usually causing pain at

FIG. 4

Photomicrograph showing fibrosis, new vascularization, and bone spiculization, with some lymphocytic infiltration. (× 220)

an early period in their development. In our experience, we have found that careful microscopic examinations of representative portions of such lesions reveal pictures fundamentally so different from that of osteitis fibrosa as to permit of slight chance of diagnostic error.

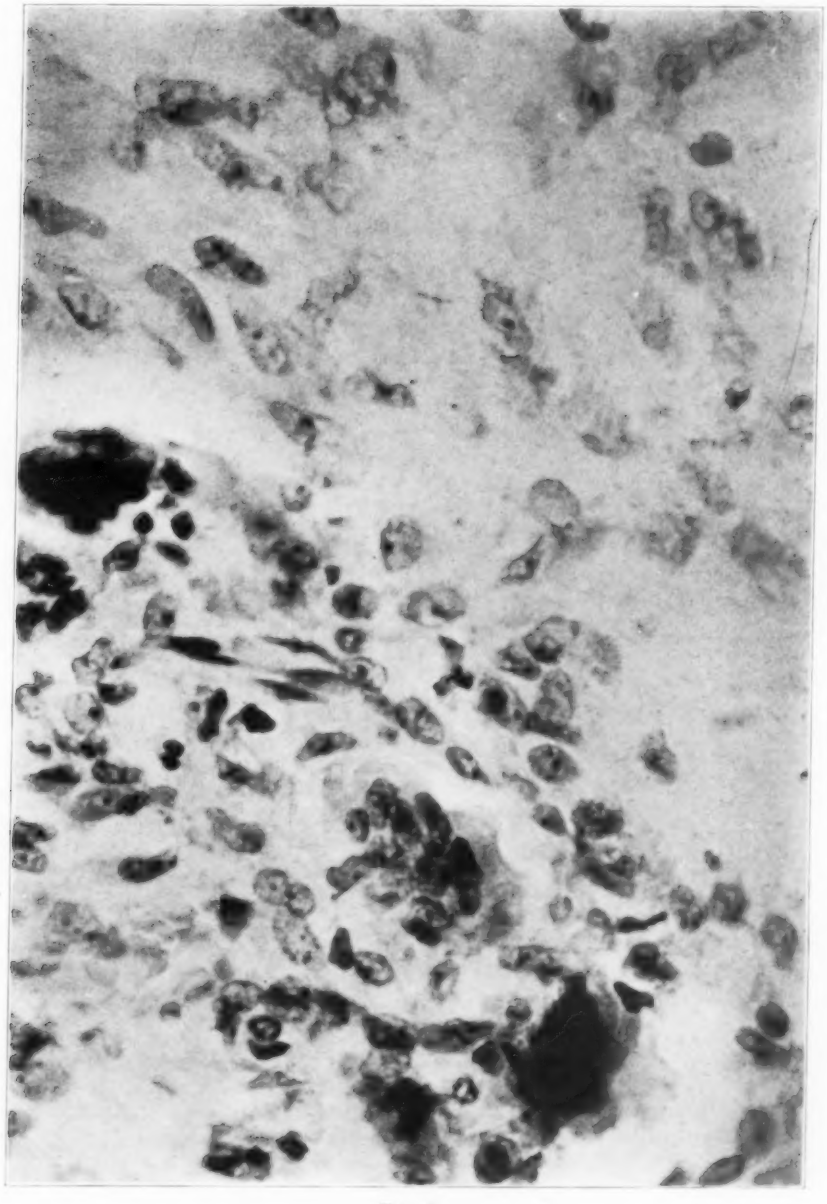

FIG. 5

Photomicrograph showing young fibroblastic tumor with interspersed giant cells. (× 440)

Radical procedure in cases of osteitis fibrosa is not indicated; curettement, or curettement with collapse of the cavity walls, and splintering of the bone in the diseased area result in complete cure in practically all cases.

CONCLUSIONS

A case of osteitis fibrosa localisata of the patella, the third on record, is here reported.

We believe osteitis fibrosa localisata to be a pathological complex, dependent upon altered osteoblastic-osteoclastic activity.

Conservative treatment is indicated.

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TREATMENT OF DISPLACED TRANSVERSE FRACTURES OF THE NECK OF THE RADIUS IN CHILDREN

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Operative removal of the head of the radius in children is seldom indicated, owing to the growth disturbance thereby produced. Effective methods of closed reduction are, therefore, of great importance, since practically perfect alignment of the fragments is necessary to insure smooth and painless rotation.

The method to be described is applicable only to complete fractures of the neck, or that portion of the radius between the head and the insertion of the biceps, with displacement, and possibly to epiphyseal separation. The annular or orbicular ligament must be intact.

The procedure is based upon the following anatomical facts: the head, which is button-shaped, is covered both on top and on the sides with cartilage and articulates with the capitellum or the radius, and laterally with the radial notch of the ulna. The head is tightly gripped by the annular ligament which surrounds it and binds it to the radial notch. It is firmly anchored to the humerus above by the strong external lateral ligament which is inserted into its fibers, especially before and behind, thus forming effective counterextension against traction. No muscles are inserted into the head and neck, and displacement cannot occur unless the annular ligament is torn. The supinator muscle, which arises from the ulna, below the radial notch, and passes around the posterior border of the radius, is inserted into the lateral border of the radius in its upper third, below the neck, and the biceps is inserted into the radial tubercle. Both of these muscles tend to displace the upper end of the lower fragment inward against the ulna and sometimes backward.

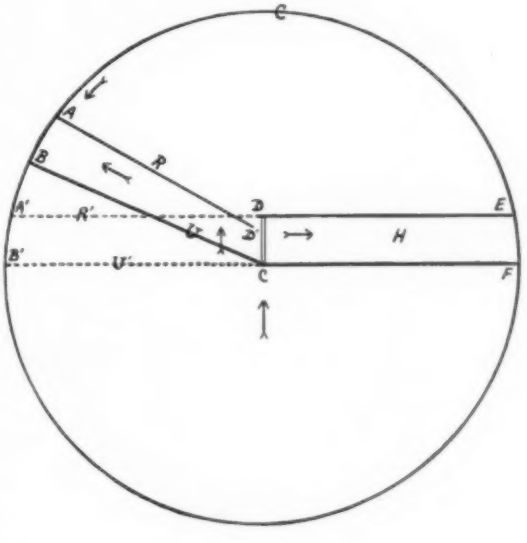

FIG. 1

Diagrammatic illustration of the mechanics of reduction. (See text for explanation.)

In order to reduce such a fracture, a force must be applied which will

FIG. 2

Case 1, Louise F., injured April 14, 1932. Anteroposterior and lateral roentgenograms showing backward and inward displacement of the proximal fragment of the right radius upon the distal portion or head.

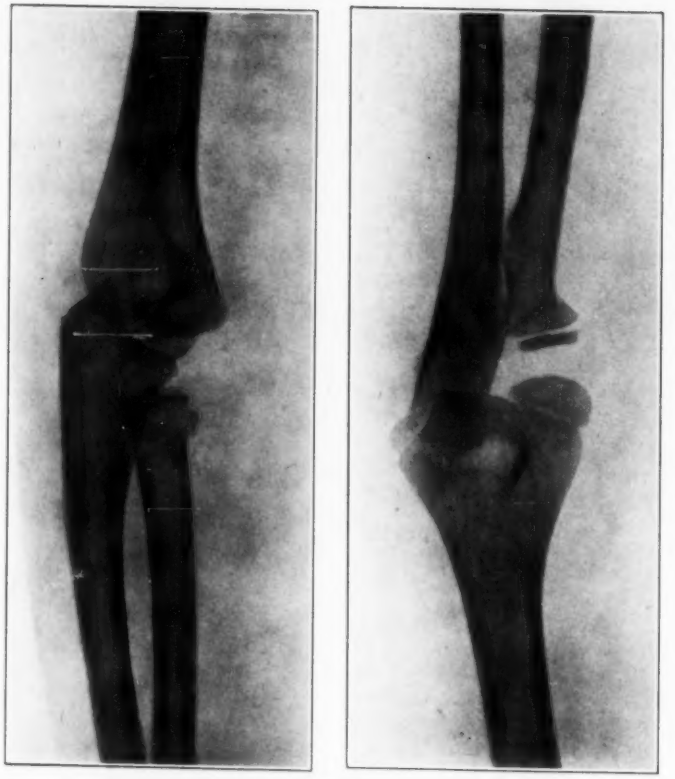

FIG. 3

Case 1. Roentgenogram taken immediately after reduction. Note restoration of alignment.

separate the fragments longitudinally, acting in opposite directions on the two portions of bone, but it must also force the upper end of the ulna outward to meet the fixed proximal portion or the head. These requirements are met in the following procedure:

An assistant grasps the arm and fixes the humerus, placing one hand against the inner condyle to act as a fulcrum for leverage. Another assistant uses traction on the arm and forces the forearm inward until the carrying angle is obliterated. He also supinates the forearm to relax the supinators. The position is checked by roentgenograms and, if the fracture has been reduced, a cast is applied with the arm in complete extension. The cast is worn two weeks and then removed, following which physiotherapy is instituted.

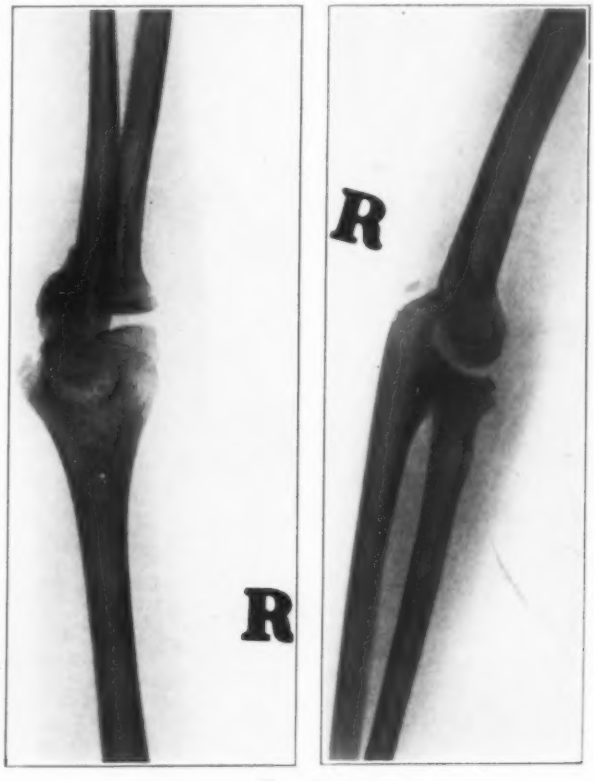

FIG. 4

Case 1. Roentgenogram showing the appearance of the bones in February 1934. Note the entire absence of any evidence of previous fracture.

The elasticity of the ligaments and other joint structures in children enables one to thus revolve the forearm inward on a vertical axis passing through the inner condyle.

The mechanics of reduction would seem to be as follows (Fig. 1): $AD'DE$ represents the line of the outer border of the arm, interrupted at the point of D' by a fracture. BCF represents the inner border with this line intact, but broken by the joint at point C. AD' is the radius distal to the fracture, with the upper end displaced inward by muscle pull. DE is the proximal fragment plus the humerus. BC represents the ulna. The humerus (H) being fixed, a sufficiently strong force applied against the wrist at A causes the forearm $ABCD$ to move to the position $A'B'CD$, thus obliterating the carrying angle of the elbow. The traction tending to straighten the line $AD'DE$, the leverage exerted against the fulcrum at C, and relaxation of the supina-

tors by complete supination of the forearm, all unite to overcome shortening and to force the displaced bone into proper alignment.

This method has been tried in two cases in children. In both instances reduction was satisfactory. We have not tried the method in adults. It would seem that the size of the limb, plus the comparative inelasticity of the ligaments and other soft tissues, would render the method inapplicable to adults.

In Case 1 the patient now has a perfectly normal arm in all respects, with the exception of ten degrees' limitation of flexion. The carrying angle is normal. Another child, a clinical patient, disappeared after the removal of the cast; consequently her present condition is unknown.

LOCALIZED ADHESIVE SPINAL ARACHNOIDITIS *

An Obscure Cause of Radiating Low Back Pain

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We wish to report a case of localized adhesive spinal arachnoiditis which was improved by operation, and to discuss briefly its pathological and clinical significance.

This disease has been referred to in the literature as intradural cysts of the spinal meninges, circumscribed serous spinal meningitis, leptomeningeal cysts, and, finally, it has been described by Stookey as localized adhesive spinal arachnoiditis.

Although pathological descriptions of arachnoid cysts appeared over seventy-five years ago, Munro states that pathologists questioned this lesion as a primary entity when he first discussed the subject in 1897. True leptomeningeal cysts have not been histologically demonstrated. However, the clinical syndrome of the localized and generalized forms of arachnoiditis was not appreciated fully until 1900, when Horsely, Krause, and others reported their findings. Spiller made the first surgical observation in 1903; his patient was still alive and well in 1909.

The original observers emphasized the fact that the symptoms of this lesion are those of a circumscribed compression of the spinal cord, and that the condition cannot be distinguished clinically from cord tumor. Little has been added to this conception despite the advances in diagnostic procedures. In particular there exists uncertainty as to the pathogenesis. It is remarkable that Stookey made a correct preoperative diagnosis of adhesive arachnoiditis in his last two cases. The chief factor in the differential diagnosis is a knowledge of this lesion. Fortunately, the brilliant results of the surgical treatment of tumor of the spine have justified early operative exploration. The relief obtained from exploratory laminectomy in arachnoiditis has been equally satisfactory. Recent reports of similar pathological conditions in the brain and cerebellum apparently furnish the key to heretofore obscure syndromes, such as migraine.

CASE REPORT

H. T., No. H 680, white male, aged thirty-two years, a barber, was first seen on February 2, 1933, when he complained of low back pain associated with bizarre widespread radiated pain of the abdomen and lower limbs, which had been initiated three months previously by heavy lifting. The history was suggestive of sacro-iliac strain, associated with sciatica. Conservative measures had failed to alleviate his symptoms. Further interrogation revealed a history of insidious low back discomfort of three years' duration, which appeared chiefly at night and which was relieved by active locomotion and

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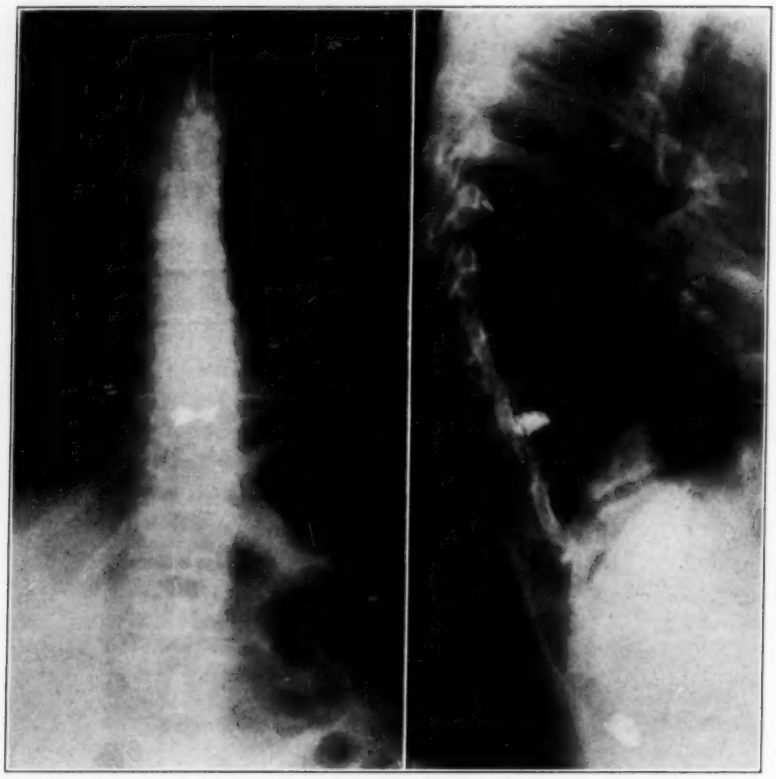

FIG. 1

Anteroposterior and lateral roentgenograms of the dorsolumbar spine, following cysterna lipiodol injection. The saddle-shaped block is clearly depicted at the level of the tenth dorsal vertebra. This saddle-shaped deformity has been considered characteristic of tumor of the spinal cord.

the usual analgesics. Headache had been prominent since the onset of his present illness. He was becoming gradually totally disabled, and was confined to a wheel chair. In this position, he experienced some relief of pain and was able to sleep.

The past history also revealed that the patient had had three severe sunstrokes between the ages of fifteen and twenty years, periodic attacks of dizziness during his twenty-fifth year, and constipation. There was also a history of atypical asthmatic attacks and general weakness during adolescence. The family history was essentially negative.

Physical examination showed a well developed, adult, white male who did not appear to be acutely ill. Objectively, only moderate spasm and tenderness over the third and fourth lumbar vertebrae were elicited. All tests for sacro-iliac and lumbosacral disease were negative. The roentgenographic findings were not remarkable.

Despite a period of treatment with back support and physiotherapy, the condition persisted without remission, and, about one month later, the first neurological signs were noted: an absence of the abdominal and left cremasteric reflexes, and exaggeration of the deep tendon reflexes of the lower extremities. A slight left dorsal scoliosis was also evident, as well as a positive right La Guerre sign. Pronounced tenderness of the lumbar spine and a bilateral pitting oedema of both legs strongly suggested a destructive lesion of the spine. The patient now complained bitterly of widespread, lancinating, radiating low back pain, and was obviously in agony. Three months after the initial observation,

FIG. 2

High-power photomicrograph of the subdural tissue removed at operation. The lower area shows young fibrous connective tissue, containing a large number of polymorphonuclear leukocytes. The superficial layer of this tissue shows in part a layer of cells resembling the endothelial type. Most of the circumference, however, is surrounded by fibrinous exudate with a number of polymorphonuclear leukocytes and mononuclear exudate cells. The connection between the fibrous tissue and fibrinous exudate is very intimate, so there is no doubt that the fibrinous exudate is in the stage of organization. Sections of the ligamentum flavum, the dura, and the bony laminae did not show any remarkable pathological changes. Cultures from the tissue and the spinal fluid remained sterile.

he had noted some spasticity of the feet during plantar flexion, marked constipation, and difficulty in urination, but no other motor or sensory disturbances.

Repeated examinations elicited some neurological evidence of spinal-cord localization. The deep tendon reflexes were exaggerated and associated with bilateral ankle clonus and Babinski signs, but no objective muscular weakness or sensory disturbance were demonstrable. The examination of the spinal fluid showed typical Froin's syndrome; all other pertinent laboratory tests were negative. Cysterna injection with lipiodol revealed by roentgenogram a definite saddle-shaped block at the level of the tenth dorsal vertebra. The check-up fluoroscopic examination showed that the block level remained unchanged. The tentative diagnosis was tumor of the cord at the tenth dorsal vertebra or at the twelfth segment of the cord. Exploratory laminectomy was indicated.

On May 5, 1933, under ethylene anaesthesia, a laminectomy was performed from the ninth dorsal vertebra to the first lumbar vertebra inclusive. The dura did not pulsate until all of these laminae had been removed, and up to this point the extradural passage of the exploratory probe was obstructed. The probe could now be passed easily up and down the canal. The dura was carefully opened at the mid-line, and was found to be thickened, as were the underlying membranes. The leptomeninges were opaque and adherent to the dura, thus obliterating the subdural and subarachnoid spaces. When the subdural tissues were incised, there was a generous gush of clear spinal fluid from above

this level. Adhesions were separated as far as possible, and the entire field was freed of constricting bands. The cord showed no evidence of tumor. The dura was closed with fine interrupted silk sutures. Drainage was not considered necessary because the entire pathological picture was clearly that of a chronic inflammatory nature. The rest of the wound was closed with interrupted catgut and the skin with dermal sutures. The patient was returned to his room in excellent condition.

The immediate postoperative convalescence was uneventful. There was the usual disturbance of the bladder lasting for three days, which required catheterization. Enemata were necessary for about three weeks until bowel control returned. The temperature rose abruptly to 105 degrees Fahrenheit and remained above 103 degrees for several days after the operation, unaccompanied by any constitutional reaction, and could not be explained. The wound healed by primary intention.

Severe nocturnal pain persisted for several months, necessitating the administration of morphine, but the patient was active three weeks after operation, and the dependent oedema gradually subsided. The patient is ready to return to his occupation at the time of writing, February 1934.

There remains a residual exaggeration of the deep tendon reflexes, but no persistent clonus or Babinski signs. Most gratifying is the absence of all spontaneous pain and local back tenderness. The gait, which had been slightly ataxic after operation, is normal. However, there remains some degree of residual, postoperative, subjective sensory changes. There is a twenty per cent. loss of reaction to cotton in the right lower extremity. Pallesthesia shows a twenty per cent. loss on the right side, but none on the left. Two-point discrimination is slightly impaired on the right side and is normal on the left. Pain and thermal sensations are decreased about fifty per cent. on both sides. Proprioceptive sensation in the great toes is normal. All of these findings refer to the lower limbs up to the level of the umbilicus.

This case is interesting from a clinical and pathological view-point. It is becoming more and more evident that a most careful evaluation of low back pain, associated with radiated pain, is imperative. The "sciatic syndrome" is a symptom complex which has been and still is causing confusion as to its clinical conception. Radiating pain is a prominent feature in the great majority of cases of low back pain seen by the orthopaedic surgeon. The intraspinal source of much of this obscure radiated pain is being more and more emphasized. A clinical classification is helpful and urgent in the evaluation of this symptom which will remain for the most part a clinical one. The following classification is both practical and direct:

1. Idiopathic or Mechanical: There is evident an underlying involvement of the osseo-arthritic structures or their adjacent soft parts, alone or combined. Where there are no neurological signs of impairment of the lumbosacral root or nerve, the cause is a mechanical one. Those conditions which present objective signs, pointing to involvement of these roots or nerves, are considered as radiculitis or neuritis.

2. Symptomatic: The sciatic syndrome is an early and prominent feature of the clinical picture. The underlying cause may be neoplastic, inflammatory, vascular, or degenerative diseases of the spine, pelvis, cord meninges, roots, or nerves in this area.

3. Neuralgic: This group is surely very rare and, at best, ques-

tionable, but one may, with certain reservations, include in it instances of paroxysmal lancinating pains in the low back without organic neurological signs and without evidences of involvement of the regional bony or soft parts.

Even this analysis accentuates the diagnostic difficulties encountered. Nothing can replace a careful and complete physical examination. Despite the almost innumerable sources of the symptoms under discussion, the orthopaedic surgeon must, above all, determine whether or not the patient belongs in the mechanical group. This can be accomplished by direct examination. It is useful to employ Steindler's four cardinal diagnostic points for the positive determination of low back pain: tender-point localization, position of relief, position of aggravation, and relief following immobilization. It is also apparent that, in the more obscure instances, the diagnosis of low back pain requires the enlistment of the entire field of medicine. Finally, there is localized adhesive spinal arachnoiditis, which is almost impossible to differentiate definitely. Peculiarly enough, the generalized forms give rise to practically the same symptoms as the localized variety, although a greater degree of cord degeneration will follow in the former, if not relieved. In this case, only after a period of prolonged observation was it possible to determine the final localization of the underlying pathology.

Early operation may prevent a secondary transverse myelitis and subsequent cord degeneration. While it is difficult to differentiate this lesion from cord tumor, the outstanding motor disturbances may suggest the basic cause. Disturbances of the bladder and rectum occur late in the evolution of this condition, and are not usually complete. The following characteristics have been quite constantly observed: long duration of symptoms, extremely slow evolution of symptoms, wide distribution of pain not corresponding to a root area, and Froin's syndrome.

The etiology and pathology of this lesion have been doubtful and controversial. The pia and arachnoid are liberally supplied with blood vessels (Macewen), which enhances the possibility of a primary inflammation. Because of the frequency of inflammatory adhesions in other serous cavities, it is reasonable to expect similar sequences in the delicate meninges, as a result of either septic or aseptic inflammations. The pathological findings in this case indicate a primary, non-specific, localized, inflammatory lesion of the arachnoid, probably of embolic origin, and this case is presumably the first to substantiate this claim. It is well known that such a condition may be secondary to trauma, tuberculosis, and lues. The subdural spaces should be explored in all cases subjected to laminectomy because of paraplegia.

ARTHROTOMY AT THE KNEE—POSTERIOR INCISION

BY ARMIN KLEIN, M.D., BOSTON, MASSACHUSETTS

The approach to the knee joint offered below is by the posterior route. It differs only slightly perhaps in position from other approaches reported previously by Brackett and Osgood[1], Henderson[2], and others; but it has an advantage over these incisions in that it is the most direct posterior route to the internal posterior compartment of the knee joint, passing through natural planes of cleavage, and necessitating a minimum amount of dissection in an area free from important blood vessels and nerves. From its location it allows free access to, widest exposure of, and above all, dependent drainage from, the internal posterior compartment of the knee joint, when the patient is lying in the usual supine position.

For this approach an incision about four inches long is made over the internal side of the posterior aspect of the knee joint (Fig. 1-A). The incision runs parallel with the long axis of the leg and is just external to the semitendinosus muscle. The center of the incision is over the knee-joint line. The subcutaneous fascia is incised, and the incision is deepened by blunt dissection in the plane between the semitendinosus and the inner head of the gastrocnemius muscles (Fig. 1). These muscles are retracted to expose the fascia and fat over the internal femoral condyle. The fascia and fat are incised and retracted, thus exposing the capsule of the knee joint. Up to this point, the exposure gained is limited internally and superiorly by the borders of the semitendinosus and semimembranosus muscles. The lower end of this incision extends down to the superior border of the popliteus muscle. The capsule is then opened by a longitu-

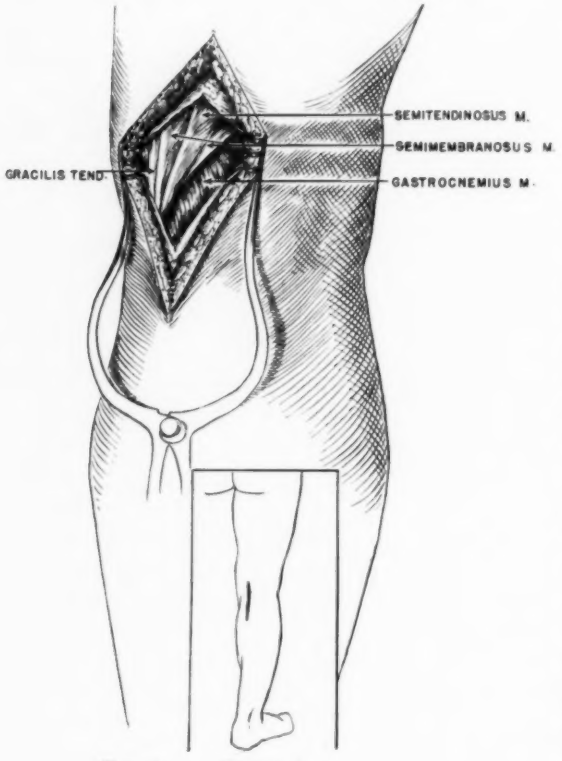

FIG. 1 FIG. 1-A

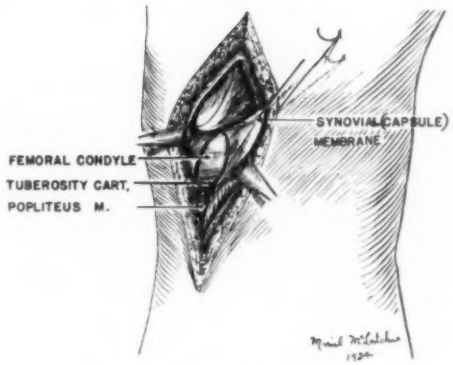

FIG. 2

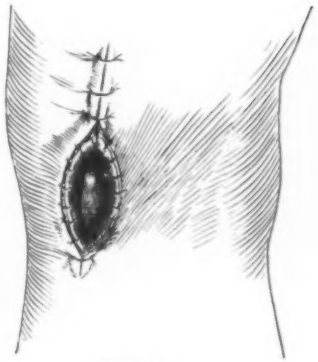

FIG. 3

dinal incision in the same line as the skin incision. The synovial membrane lining the posterior chamber is incised, thus exposing the cartilaginous surface of the tibial tuberosity (Fig. 2).

In cases of suppurative arthritis, the synovial membrane and capsule are sutured to the subcutaneous fascia with interrupted chromic catgut sutures. This effects a wide exposure of the posteromedial articular chamber. The muscles are enclosed and walled off within the reflected synovial membrane and fascia (Fig. 3). A cigarette drain may then be inserted into the cavity and held by a silkworm-gut stay suture. The skin incision above and below the resulting funnel-like cavity is approximated with interrupted silkworm-gut sutures.

Another paper, dealing with the specific utilization of this approach in draining suppurative arthritis of the knee joint, is now in course of preparation by the author.

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LUMBOSACRAL FACETECTOMY FOR RELIEF OF SCIATIC PAIN

A Case Report

BY C. L. MITCHELL, M.D., DETROIT, MICHIGAN

From the Division of Orthopaedic Surgery, Henry Ford Hospital, Detroit, Michigan

Recent articles by Ghormley, Williams, and others have drawn attention to the importance of the articular facets in the production of sciatic pain. Although Putti described this syndrome in 1927 and recommended operative removal of the facets in certain cases, we have no record of a similar operation in this country prior to Ghormley's report in 1931.

That this operative procedure offers a means of relief from sciatic pain in selected cases has been shown conclusively by the case reports of the above authors. Impingement of the fifth lumbar nerve in the lumbosacral intervertebral neural foramen should be suspected in all cases of sciatic pain that have not responded to adequate conservative treatment. Danforth and Wilson have pointed out that a disproportion exists between the fifth lumbar nerve and the lumbosacral foramen. Thus it follows that nerve irritation can occur with pathological conditions of the foramen and especially of the lumbosacral articulations which form the roof of the canal. Putti has placed emphasis on vertebral arthritis as a causative factor. Williams and Yglesias, and Ayers have demonstrated the relation of sciatic pain to narrowing of the lumbosacral disc and consequent reduction in size of the intervertebral foramen. Ghormley has recently described the "facet syndrome", mentioning in addition the possibility that fractures of the facets produce sciatic pain.

Operation should not be resorted to until after conservative treatment has been given a thorough trial. Care should be taken to exclude lumbosacral tuberculosis, spinal-cord tumor, or metastatic tumor involving the lumbar vertebrae, as these conditions may present a very similar clinical picture.

The following case is reported as it further illustrates the efficacy of this operative procedure:

Mr. T. A., aged thirty, was admitted to the Henry Ford Hospital on July 13, 1933, complaining of low back pain and sciatica. There was a history of intermittent attacks of "lumbago" during the previous four years. The onset of symptoms had always been quite sudden, usually having been precipitated by a quick stooping movement. He had been disabled for over two months with such an attack and during the month previous to admission he had noticed severe radiating pains down the posterior aspect of the left thigh and calf to the foot. Treatment had consisted of physiotherapy, vaccine injections, supportive belts, and osteopathic and chiropractic adjustments. During the past three years he had lost thirty pounds in weight.

Examination revealed findings characteristic of sciatic scoliosis. There was a

contralateral list of the spine to the right, with a right dorsal left lumbar scoliosis. The lumbar spine was flattened and muscle spasm was quite pronounced. Lasègue's sign was positive on the left side. There was loss of the left gluteal fold and atrophy of the thigh and calf. The left patellar reflex and ankle clonus were not obtained even with reinforcement. There was a suggestion of hypaesthesia over the dorsum of the left foot, but this was not definite.

Lateral roentgenograms of the lumbar spine showed narrowing of the posterior portion of the interspace between the fifth lumbar vertebra and the sacrum.

Treatment at first consisted of rest in bed on a firm mattress with daily baking and massage of the back and left hip.

On July 21, under general anaesthesia, the left sciatic nerve was stretched. No improvement was noted following this procedure.

On July 25, a plaster hip spica was applied because of continued sciatic pain. This was bivalved on August 2 and physiotherapy was continued. A sacro-iliac belt was applied and the patient was discharged on August 9.

On August 28, he was readmitted to the Hospital. Lumbar puncture, including Queckenstedt's test, revealed no abnormalities. Neurological examination by Dr. G. O. Grain revealed weakness of the left tibialis anticus, peronei, and extensors of the toes. In addition, there was muscle atrophy, absence of the deep tendon reflexes, and slight sensory changes in the foot. The diagnosis was sciatic neuritis, left side, with no evidence of pathology of the spinal cord. Patient was discharged on September 2.

FIG. 1

Lateral view of lumbosacral spine. Note posterior narrowing of lumbosacral disc, subluxation of facets, and closure of foramen.

On September 14, the patient was readmitted by ambulance. The pain in the left leg had become unbearable and the patient had continued to lose weight. He was placed in bed with Buck's extension to both lower extremities and received diathermy to the left thigh daily. Epidural injection of novocain was done by Dr. A. S. Crawford on Septem-

ber 22 and repeated on September 30, without improvement in symptoms. A check-up neurological examination by Dr. Grain on October 13 revealed increased muscle weakness and definite sensory changes over the dorsal and lateral aspects of the left foot. A diagnosis was made of impingement of the fifth lumbar nerve at the intervertebral foramen.

An operation was performed on October 18. A curved incision, about six inches in length, was made from the level of the third lumbar vertebra just to the left of the midline, curving gradually downward and laterally. The erector spinae muscle was dissected subperiostially from the spinous processes, laminae, and sacrum, and retracted laterally, exposing the lumbosacral articular facets. These facets were removed with an osteotome and rongeurs, exposing the fifth lumbar nerve which was found to lie in close proximity to the anterior surface of the sacral facet. A Hibbs fusion of the lumbosacral spine was then done and the wound was closed in layers.

The day following operation the patient reported complete relief from sciatic pain. Convalescence was uneventful and on December 16 he was allowed up wearing a Goldthwait back brace. A check-up neurological examination, three months after the operation, revealed a full return of motor and sensory functions of the left lower extremity.

The patient experienced no further pain in the back or extremity and returned to work on February 1.

SUMMARY

A case is reported of sciatic pain, due to impingement of the fifth lumbar nerve in the intervertebral foramen, which was successfully treated by facetectomy and lumbosacral fusion.

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A MODIFICATION OF SKELETAL TRACTION IN FRACTURES OF THE LONG BONES

Report of Three Cases *

BY WILLIAM H. BAILEY, M.D., OKLAHOMA CITY, OKLAHOMA

When the usual apparatus for skeletal traction is applied, the patient is confined to bed for from three to four weeks. The object of the modified splint described in this paper is to make the patient ambulatory at a much earlier stage, and to aid in a more complete reduction at the first sitting. In the treatment of compound fractures especially, this splint

Fig. 1

Splint in position with cast applied, just before bows and turnbuckles are removed.

affords an almost ideal method of fixation, as there is an open space entirely around the limb so that the dressings can be changed easily and without interfering with the position of the fragments.

The splint (Fig. 1) consists of two Kirschner bows with wires or Steinmann pins connected at the sides by two turnbuckles, so placed that the bows can be strongly pushed apart.

The application of the splint is best accomplished with the patient under a general anaesthetic. In some locations, and with some patients, a local anaesthetic may prove satisfactory.

The fractured limb is placed in a position as near normal as possible. With the aid of an assistant, or of some temporary pulling device, strong traction is exerted on the distal fragment to overcome as much of the shortening as possible. The two Kirschner wires, or Steinmann pins, are now introduced at right angles to the bones and at a distance from each other just equalling the length of the turnbuckles when they are screwed up to their shortest lengths. The wounds in the skin at the points of

* From Wesley Hospital, Oklahoma City, Oklahoma.

entrance and exit of the wires are protected by placing small squares of sterile gauze around the wires and fastening them with a strip or two of adhesive plaster. If the wires or pins are too close together, the turnbuckles cannot be placed between the bows after they are in place. If the wires are too far apart, the turnbuckles, after the bows are in place, may not extend far enough to disengage the fragments and to permit proper alignment. The Kirschner bows are now fastened in position on the two wires and the wires tightened, so as to put them on tension. The two turnbuckles are next fastened in position between and on the sides of the bows, near the wires. As the turnbuckles are screwed out or lengthened, the proximal and distal fragments of the fracture are slowly pushed apart. When a sufficient separation has been secured to permit the ends of the fragments to become disengaged, the fragments usually drop into fair alignment of their own accord. The positions of the fragments are now checked by fluoroscopic examination and, if not satisfactory, further adjustment is made by manual manipulation and by changing the amount of push exerted, first by one turnbuckle and then by the other. When the proper alignment has been obtained, the turnbuckles are unscrewed a little, permitting the ends of the bones to come back into firm contact with each other. Sufficient extension, however, is maintained to prevent the subsequent muscle spasm from pulling the fragments out of line.

After satisfactory reduction has been secured, and if injury to the skin and soft parts does not contra-indicate, a plaster cast is applied at once. This cast incorporates both of the Kirschner wires, but the bows and turnbuckles are not included. Usually, this cast extends some distance above and below the site of the fracture, although it is not always necessary to immobilize the joints proximal to the splint. After the cast has set and dried, and if proper reduction has been retained as shown by the roentgenogram, the bows and turnbuckles are removed and the wires are held in position by the cast. The ends of the wires may be turned down or cut off and covered by a few turns of a bandage.

Occasionally, it is impossible to get sufficient extension to permit proper reduction at the first visit. In such instances, the splint is left in position, with strong extension exerted by the turnbuckles, and at frequent intervals a few turns of the turnbuckles are made until such time (frequently within a day or two) as the fragments are separated sufficiently to disengage the overlapping. Then the reduction is completed as before.

This splint is not applicable to fractures of the upper third of the femur or humerus, as there is not sufficient space to place the upper wire through the proximal fragment in a satisfactory position.

CASE REPORTS

Case 1. Mr. S., a middle-aged man, was injured in an automobile accident. He suffered a fracture about the middle third of the radius and ulna of his left forearm. A preliminary roentgenogram showed some comminution, with overriding of both bones. Pins were introduced above and below the fracture, and the two bows with turnbuckles

FIG. 2

Case 2. Anteroposterior and lateral roentgenograms on day of admission.

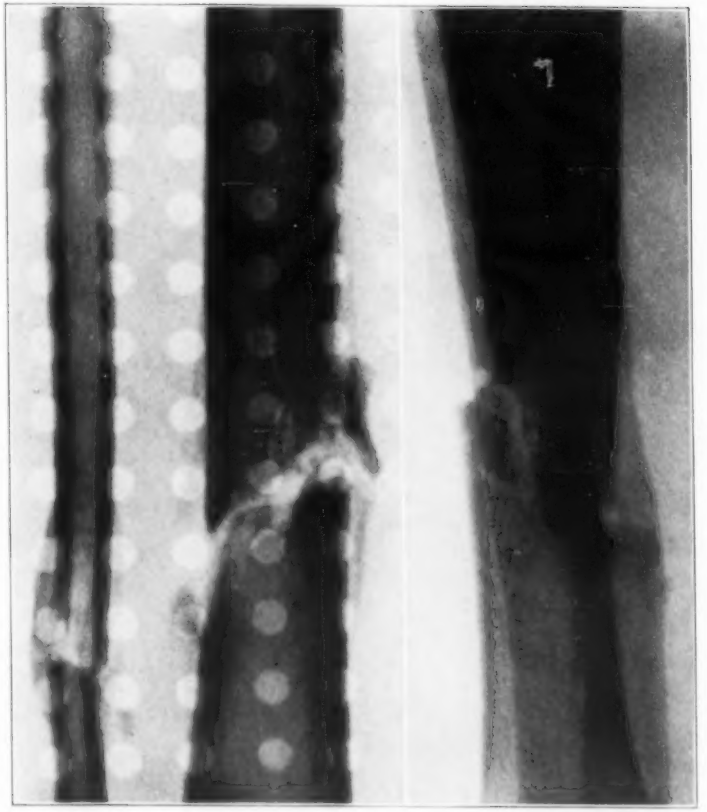

FIG. 3

Case 2. Anteroposterior and lateral roentgenograms after cast, wire, and pin had been removed and the leg had been put in a metal splint.

were attached. The splint was left in position with rather strong extension for two or three days.

Further adjustment was then made and a plaster cast was applied. The bows and turnbuckles were removed when the cast was dry. The patient returned to his work in a packing house in about ten weeks.

CASE 2. W. S., a boy of sixteen years, was also injured in an automobile accident. He suffered a compound comminuted fracture of the lower third of the tibia and fibula of his right leg. Figure 2 shows the position of the fracture when the patient was admitted to the hospital. The splint was applied and the fracture reduced. The wound was dakinized for about a week and then the patient was allowed up in a wheel chair. As soon as the wound healed sufficiently to require a dressing every other day only, a shell cast was applied, the bows and turnbuckles were removed, and the patient was allowed to go home on crutches. Figure 3 shows the position of the fragments when the cast was removed and the leg put in a posterior aluminum splint.

CASE 3. Mrs. D., a woman about fifty-five years of age, was injured by a fall in her home. She suffered a comminuted fracture of both bones of the lower leg, involving the ankle joint, and a posterior dislocation of the astragalus. So much of the articular surface of the tibia was broken off that an attempt to reduce the dislocation and hold it in position by a plaster cast failed. The extension splint was applied and reduction was obtained. The roentgenogram taken at this time showed too much joint space and a narrowing of the width of the joint; therefore, the tension was reduced sufficiently to permit the foot to come up into better position. After two days, a cast was applied, the bows and turnbuckles were removed, and the patient was sent home. This case is still under treatment, so final results cannot be shown.

CONSERVATIVE TREATMENT FOR COMPLETE DISLOCATION OF THE ACROMIOCLAVICULAR JOINT*

BY AARON H. TRYNIN, M.D., BROOKLYN, NEW YORK

In a recent publication Schneider[1] reported his method of autoplastic reconstruction of acromioclavicular dislocations with the use of fascia lata. An open operation, followed by immobilization in a Dillehunt plaster for six weeks, is the method advocated. Full function, he states, should be recovered in six months. Two cases are reported,—the first patient was seen seven weeks after injury and an operation was performed nine weeks later; the second patient was operated on two days after injury.

In this type of dislocation there is a tearing of the acromioclavicular and coracoclavicular ligaments, the degree of dislocation depending on the extent of the tear. In a previous communication,[2] the author described in detail the Böhler clavicular splint and demonstrated that, by adequate immobilization with the use of this apparatus, it was possible to obtain a healing of the partially torn ligaments and a restoration of the acromioclavicular joint in a case of incomplete dislocation. This was accomplished with a minimum of discomfort to the patient. Since then, the writer has had occasion to apply the same method of treatment to a case of complete dislocation of the joint, with an excellent result.

FIG. 1

Roentgenogram before reduction.

* From the Service of Dr. S. Kleinberg, Hospital for Joint Diseases, New York, N. Y.

FIG. 2

The clavicular splint applied, holding the clavicle in place.

Provided the treatment is instituted early, an open operation is not necessary. The advantages of conservative treatment over an open operation require no comment. With the use of this method of treatment, the two bones constituting the joint are maintained in apposition with no possibility of displacement. The apparatus needs little adjustment; the only care required is to have the strap over the injured shoulder, which keeps the clavicle depressed, held firmly by an ordinary buckle.

CASE REPORT

A. C., aged twenty-six years, was struck by an automobile on October 31, 1933. He complained of pain and disability of the left shoulder. The patient was seen on November 7, 1933, one week following injury. Examination revealed a swelling of the shoulder. The acromial end of the clavicle was displaced upward. The roentgenogram (Fig. 1) showed a complete dislocation of the acromial end of the clavicle.

After five cubic centimeters of two per cent. novacain had been injected into the joint, the dislocation was easily reduced. A Böhler clavicular splint was applied (Fig. 2). A roentgenogram taken immediately after application of the splint showed complete

FIG. 3

Roentgenogram after removal of the apparatus, showing complete reduction.

reduction. The apparatus was removed about five weeks later on December 12, 1933. A roentgenogram (Fig. 3) showed that reduction had been maintained. During the time the splint was worn, the patient had complete use of his extremity. At no time was the arm immobilized to his side, permitting stiffness of the shoulder, elbow, or wrist. Consequently, at the time of removal of the apparatus, the patient had a complete range of motion at the elbow and a fair range of motion at the shoulder. Two weeks later the range of motion at the shoulder was complete (Figs. 4 and 5).

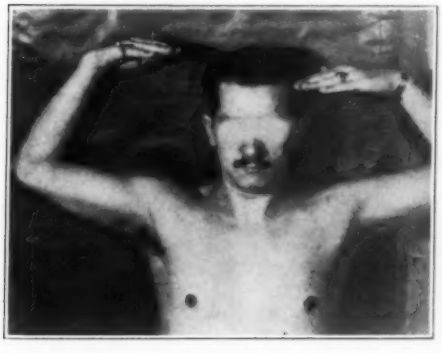

FIG. 4

FIG. 5

Seven weeks after reduction, showing complete range of motion.

COMMENT

A method that has been advocated for treatment of incomplete acromioclavicular dislocation has been used successfully for complete dislocation of the acromioclavicular joint. The method is simple with little, if any, discomfort to the patient, and obviates an open operation and a prolonged period of disability.

During the time the splint is worn, the patient has full and free use of his extremity. The shoulder joint, elbow, and fingers are free. He can use the extremity in all light occupations without fear of displacing the clavicle.

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PELLEGRINI-STIEDA DISEASE

Case Report*

BY NATHAN H. RACHLIN, M.D., BROOKLYN, NEW YORK

A complete description of Pellegrini-Stieda disease with a discussion of the literature has been given by Kulowski[1], and repetition is, therefore, unnecessary. Kulowski states that, although a number of cases of this disease (136) have been reported in European literature, no cases have been reported in this country. Since the appearance of this article, however, another case has been reported at the meeting of the American Academy of Orthopaedic Surgeons in January 1934. Doubtless, a good many more cases have come under treatment which have not been reported.

The following case is of especial interest because of the fact that the knee joint was practically ankylosed, and that a good functional result was obtained by operative measures.

CASE REPORT

H. L., male, aged fifty-four years, was admitted to the Orthopaedic Service of the Neurological Hospital, City of New York, on Welfare Island, on October 18, 1933.

He gave a history of having sustained an injury to the upper end of the right tibia in January 1932. He was admitted to the B——— Hospital on January 16, 1932, and was discharged in March 1932, but continued to receive treatment at the same Hospital for two months longer. Since then, motion in the right knee had been limited.

The patient was examined by the writer on October 26, 1933, when the following notes were made: "Joint, on upper and outer aspect, is apparently free. On the inner aspect posteriorly, there is palpable a bony bridge, extending from the upper and inner condylar region of the femur to the tibia. Knee action is about five degrees; patella, slightly movable; thigh muscles, atrophied. Diagnosis: myositis ossificans traumatica. Surgical removal of the osteoma was advised."

The roentgenographic report, made on October 19 by Dr. D. E. Ehrlich, was as follows:

"The bones of the right knee joint reveal an irregular, sclerotic, and osteoporotic process in their adjacent portions. There is some irregularity in structure of the proximal part of the right fibula near the head, which indicates a healed fracture. There is a large calcified area lying adjacent to the medial aspect of the right knee joint, which produces a definite bulge in the soft tissues.

"Spurring of the medial aspect of the tibia at the knee joint is evident. There is also an irregular tranverse healed fracture in the upper end of the tibia, with some roughening at its inner border and cross union to the fibula.

"The pelvis and upper ends of the femora reveal no abnormality except for a slight degree of osteoporosis."

An operation was performed on November 9, 1933. A six-inch longitudinal incision was made on the inner aspect of the tibia, anterior to the tumor mass. The superficial structures were dissected, and the osteoma was found to be imbedded in the tendon of the vastus internus muscle. With an osteotome, the tumor was separated from the

*From the Orthopaedic Service, Neurological Hospital, City of New York, Welfare Island.

FIG. 1
Before operation.

FIG. 2
After operation.

tibia at a point below the capsular attachment, and dissected out upward and backward, without entering the joint at its femoral attachment. The knee joint was then found to be fairly movable.

The deep structures and skin were sutured without drainage, and a knee cast was applied for one week. After active motion had been started, the patient improved rapidly.

The pathological report by Dr. Vera B. Dolgopol was as follows:

"The specimen consists of two flat pieces of bone. One piece is six centimeters long, two and five-tenths centimeters wide, and from four-tenths to one centimeter thick. It is covered by smooth fibrous tissue. At the thicker part, one lateral surface presents the bare cut surface of a hard cancellous bone. The smaller piece, two by one and five-tenths centimeters by five-tenths of a centimeter, shows one cut bony surface, and apparently was chipped off from the larger piece.

"Microscopic sections show a cancellous bone which is fibrous in some places; in other parts it is lamellar. Several pieces of cartilage and an active endochondral bone formation are seen. The osteoblasts predominate over the osteoclasts, except in the proximity of the cartilage. The marrow consists of young connective tissue with large vascular spaces, especially near the cartilage. Fat cells are present in one or two marrow spaces. The tissue on the surface of the bone consists of parallel-strand collagenous fibrous tissue, with some arteries showing endarteritic changes. No muscle fibers are found in the sections."

Physiotherapy was instituted and the patient continued to improve. When examined on December 19, 1933, he had a range of motion in the knee from 180 degrees to 80 degrees. He was discharged on January 19, 1934, and was advised to return in six months for reexamination.

[1] Kulowski, Jacob: Pellegrini-Stieda's Disease. A Report of One Case Surgically Treated. J. Am. Med. Assn., C, 1014, 1933.

TRAUMATIC DISLOCATION OF THE HIP (HEAD OF THE FEMUR) INTO THE SCROTUM

BY ANGUS G. GOETZ, M.D., DETROIT, MICHIGAN

The following case is reported because it seems most unusual. The author has been unable to find a report of a similar case in the literature.

CASE REPORT

P. J., a boy, aged ten years, while riding his scooter on September 11, 1931, was struck by an automobile and hurled about ten feet. He was rushed immediately to St. Joseph's Mercy Hospital. On examination it was found that the left thigh was abducted to beyond a right angle with the pelvis, with extreme internal rotation. There was shortening of the left extremity of about four inches. A mass could be felt within the scrotum, over which the skin was rather tense and discolored; the discoloration and swelling extended over the left inguinal region. The roentgenogram revealed the head of the left femur to be displaced anteriorly and inferiorly to the symphysis, and the greater trochanter to be avulsed slightly above its normal location (Fig. 1).

The patient was placed under gas anaesthesia and, when he was well relaxed, lateral manual traction was applied to the leg. The head of the femur was seen to move out of the scrotum with very little difficulty and to pass over the ramus of the pubis just below the inferior spine of the ilium. Then, by flexion of the thigh and circumduction, the dislocation was easily reduced. There was an immediate massive swelling of the scrotum

FIG. 1

Roentgenogram showing dislocation of the head of the femur into the scrotum and separation of the greater trochanter from the femur, as indicated by the arrow.

FIG. 2

Roentgenogram taken immediately following reduction, showing hemorrhage into the scrotum.

FIG. 3

Roentgenogram taken three and a half months following injury.

to about the size of a small grapefruit; this swelling extended into the left inguinal region. A check-up roentgenogram was taken (Fig. 2).

A support was applied for the scrotum, the legs were bandaged together in extension, and an inlying catheter was introduced. The patient was put to bed and heat was applied. On September 29, 1931, the swelling had greatly subsided, the catheter was removed, and the patient voided voluntarily.

During the first few days of his stay in the Hospital, his temperature rose to 102.4 degrees; the pulse was 148.

Laboratory findings were as follows:

Red blood cells	4,390,000
Hemoglobin	75 per cent.
White blood cells	10,550

The urinalysis was essentially negative.

On the twelfth day, a plaster spica was applied and left on for six weeks. On January 5, 1932, the patient was again examined. He was walking about with a very slight limp; there was a normal range of motion in the hips; the scrotum and testes were normal in size and consistency. The patient had apparently made a normal recovery. Figure 3 shows the roentgenogram taken at this time.

OPERATION FOR BILATERAL OSTEO-ARTHRITIS OF THE HIP*

BY HARRY GOLDBERG, M.D., LOUISVILLE, KENTUCKY

The purpose of this report is to present the record of an unusual case of bilateral osteo-arthritis of the hip, and to point out an operative procedure whereby the stability and painless movement of these hips were obtained.

CASE REPORT

Mrs. M. B., aged forty-three years, was referred on January 25, 1932, complaining of pain and stiffness of both hips, which were more noticeable on the right side.

The family history was negative.

The previous medical history revealed that the patient had walked in a peculiar fashion since she was a child. The discomfort of the hips was first noticed four years ago. The pain and stiffness of the right hip had been gradually increasing during the past two years. During this time the left hip had caused only slight discomfort. The pain had kept her awake at night and she had difficulty in lying in a comfortable position. She had been unable to sit up during the past two years, because of stiffness in the right hip. Changes of weather aggravated the condition. She had been examined for foci of infection, and her teeth had been removed, with no relief of the symptoms.

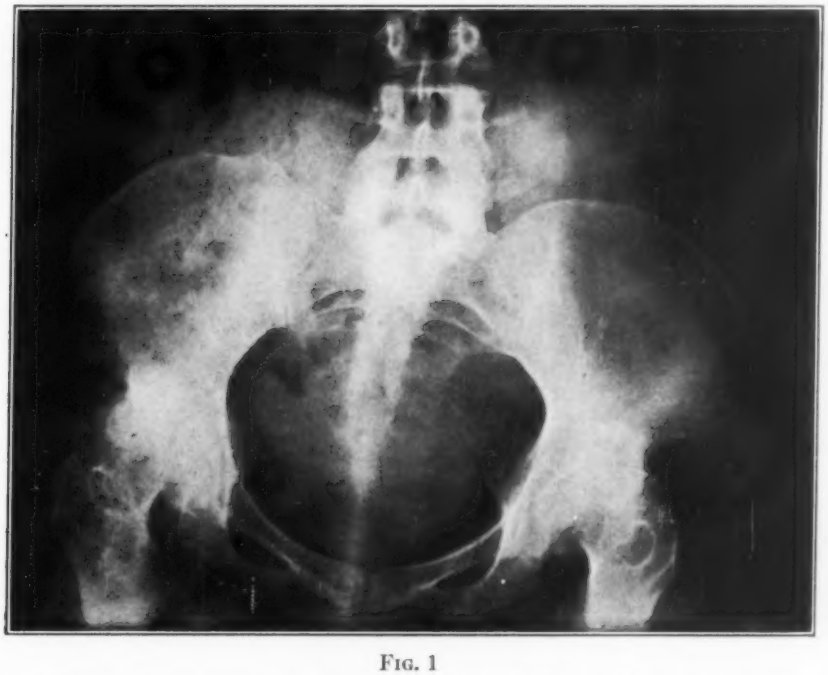

FIG. 1

Preoperative roentgenogram, showing alteration of the femoral heads with lipping and subluxation.

* Read before the American Academy of Orthopaedic Surgeons, January 10, 1934.

Examination showed the right hip to be fixed in thirty degrees' outward rotation, and motion was restricted in all directions. A few degrees of passive flexion and abduction were possible. The left hip showed an external rotation contracture of thirty degrees. Flexion was limited to ninety degrees, and abduction to ten degrees. Passive extension and adduction were normal. Both knees presented tenderness at the internal lateral ligaments. With the aid of a cane, the patient could walk with an extremely waddling gait. The right lower extremity was dragged with great effort.

The roentgenographic examination showed alteration of the shape of the femoral heads with lipping, coxa valga, subluxation, and slightly flattened and widened sockets (Fig. 1). There was distinct narrowing of the intra-articular spaces. There was present increased density with small cyst-like areas in the head and acetabulum.

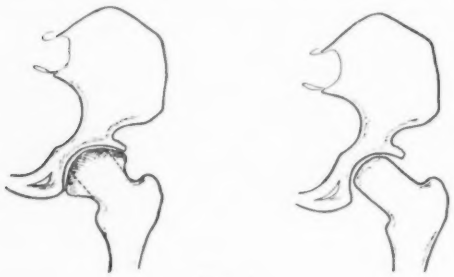

FIG. 2

Diagram of the Jones technique for remodeling the femoral head.

The right hip was operated upon on February 4, 1932. Sir Robert Jones' method of remodeling the head of the femur was the procedure employed. A Smith-Petersen approach was selected, and the incision was made between the tensor fasciae femoris and the sartorius. The rectus femoris was retracted medially, and the gluteal muscles laterally. The capsule of the hip joint was divided and the head of the femur was displaced by rotating the limb outward. The circumference of the femoral head was reduced to that of the femoral neck, leaving the cartilage at the extreme end of the femoral head. This was done with a curved chisel. The raw edges were smoothed with a rasp. The excrescences around the acetabular rim were not

FIG. 3

Postoperative roentgenogram, six months after operation on the right hip, showing the femoral head reduced to the circumference of the femoral neck, and correction of the subluxation.

disturbed. The hip was then reduced by rotating the limb inward, and the wound was closed (Fig. 2).

At this time the left hip was manipulated to increase the range of motion and to correct the outward rotation contracture.

The patient was put in a double plaster-of-Paris hip spica with the limbs in moderate abduction. She remained in the cast for seventeen days, and then was placed in balanced traction to gradually start active motion.

Six weeks after the operation, she was allowed up in a Thomas walking brace, with a cane and a crutch. The patient continued to progress in a satisfactory manner so that she was able to walk comfortably with only a cane.

Six months later, she commenced to have discomfort in the left hip, which again necessitated the use of a crutch and cane. This state of affairs continued for another six months, when it was decided that a reconstruction operation on the left hip should be done. The right hip continued to give no discomfort.

The left hip was operated on February 9, 1933. The same procedure and after-treatment were carried out as described for the right hip.

Examination on January 2, 1934, showed:

Right Hip—Flexion to 100 degrees actively, 80 degrees passively; extension normal, no hyperextension; external rotation to 30 degrees, no internal rotation; abduction to 30 degrees actively, 40 degrees passively; adduction normal passively.

Left Hip—Flexion to 110 degrees actively, 90 degrees passively; the other movements were similar to the right hip.

Roentgenographic examination showed the heads of the femora remodeled to the size of the circumference of the femoral necks, the more natural relation of the femoral heads to the sockets, the increased intra-articular spaces, and the apparent disappearance of the small cyst-like areas in the acetabular regions (Figs. 3 and 4 .

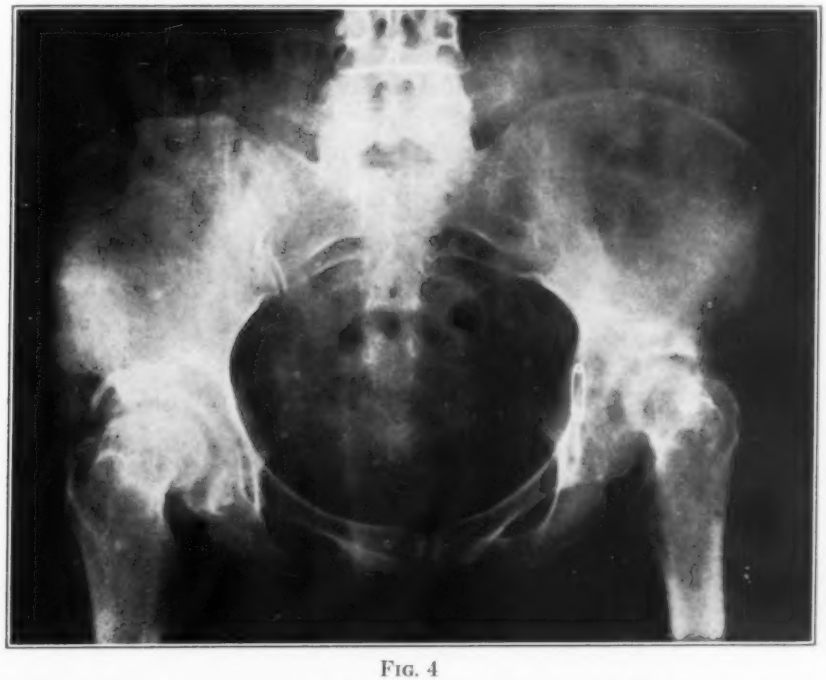

FIG. 4

Postoperative roentgenogram, taken January 2, 1934, showing both femoral heads reduced to the circumference of the femoral necks, with correction of the subluxation and apparent disappearance of the small cyst-like area in the acetabular region.

The patient is able to walk comfortably without support and without the marked waddling gait, although she still uses the cane if she walks for a long distance. She is able to sit up for the first time in two years. Her general condition has improved and she sleeps well, as she no longer has pain and can lie comfortably in any position. Her only disadvantage is some difficulty in tying her shoe laces.

DISCUSSION

The operation described minimizes the friction at the joint, which is the exciting cause of the pain and the deformity. The special feature of this operation is the narrowing of the femoral head, which takes care of the subluxation and gives a more mechanically perfect joint. The acetabular excrescences are retained, since their removal may invite a callus formation with possible ankylosis.

AN INSTRUMENT FOR WEDGING PLASTER CASTS

BY FOWLER B. ROBERTS, M.D., M.SC., F.A.C.S., AKRON, OHIO
Orthopaedic Department, Children's Hospital

For many years we used tongue blades and small wood blocks for wedging plaster casts. While fairly satisfactory this method had many faults.

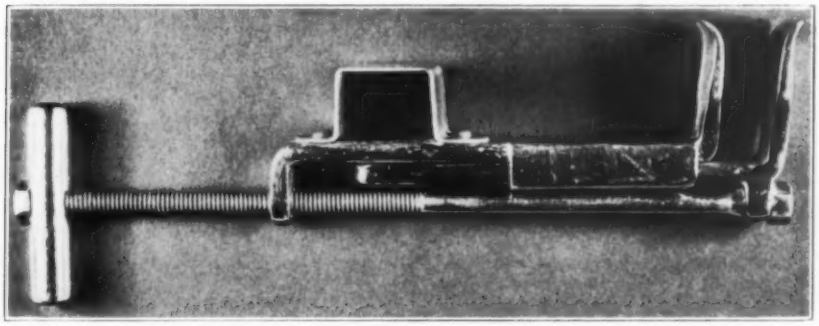

FIG. 1
Spreader assembled.

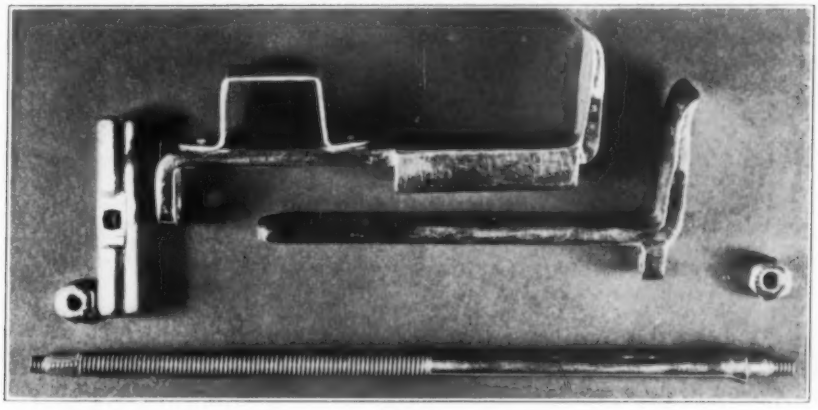

FIG. 2
Individual parts of spreader.

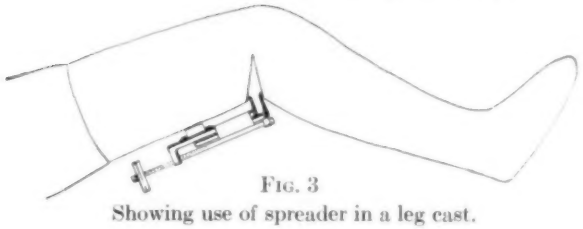

FIG. 3
Showing use of spreader in a leg cast.

To overcome these we had made in our local brace shop the spreader which is shown in the accompanying illustrations. The principle and mechanism can be readily understood from the photographs and drawing. It is convenient to have two or three sizes for casts of various sizes. This instrument has been found very useful and is, therefore, presented in the hope that others may find it of value.

BONE WEDGE "HAMMER" USED IN ARTHRODESIS OF THE SACRO-ILIAC JOINT

BY PIO BLANCO, M.D., BUFFALO, NEW YORK

From the Orthopaedic Service, Buffalo City Hospital.

In performing an arthrodesis of the sacro-iliac joint by the Smith-Petersen technique, a wedge of bone, the full thickness of the ilium, is removed from the location corresponding to the sacro-iliac joint. Thus the sacral surface of the joint is exposed. The cartilage is removed from the wedge of bone and from the sacral surface of the joint. In addition, a layer of the sacrum, about one-quarter of an inch in thickness, is removed with the cartilage. The wedge is then reinserted and driven through into the sacrum.

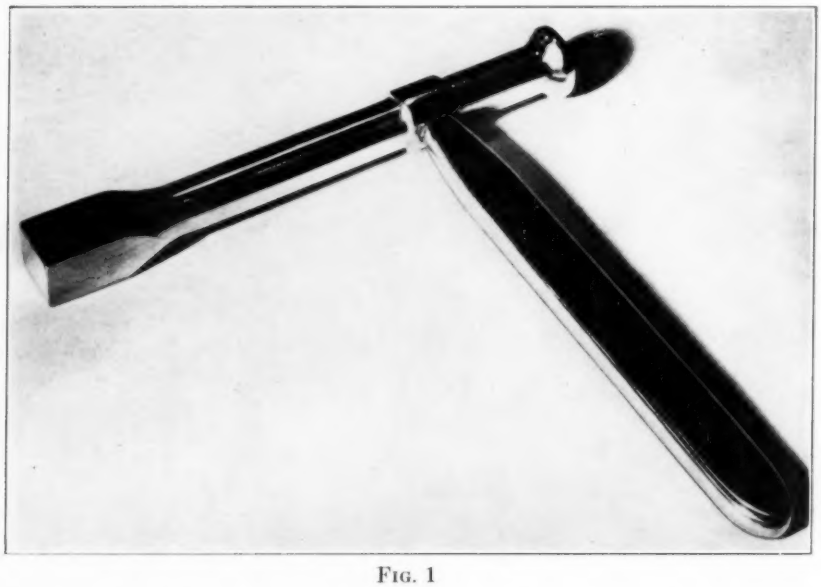

FIG. 1

Due to the great distance from the surface of the ilium to the surface of the skin, especially in obese patients, and since the retraction of the gluteal muscles does not always afford a sufficiently ample exposure, some difficulty may be encountered in driving the wedge of bone. The present instrument has been devised for the purpose of facilitating this stage of the operation.

The instrument shown in Figure 1 consists of a driving shaft, seven inches long. At one end is a flat circular head which receives the mallet. The other end consists of a flat surface, three-quarters of an inch square, which fits over the wedge of bone. The handle is seven and one-half inches long. It is welded at right angles to the driving shaft, two inches distant from its flat head.

A DEMOUNTABLE KIRSCHNER WIRE GUIDE FOR USE WITH THE ALBEE MOTOR

BY BARCLAY W. MOFFAT, M.D., NEW YORK, N. Y.

The majority of men who have used a motor-driven Kirschner wire agree that it has many obvious advantages. Of these, the foremost are the feasibility of using local anaesthesia for the introduction of the wire when it is motor-driven, because of its almost instantaneous passage through the bone; and, secondly, the greater ease in transfixing small fragments—such as those of the olecranon—or bones of curving surfaces,—such as the patella, when it is desired to use traction on a short quadriceps muscle.

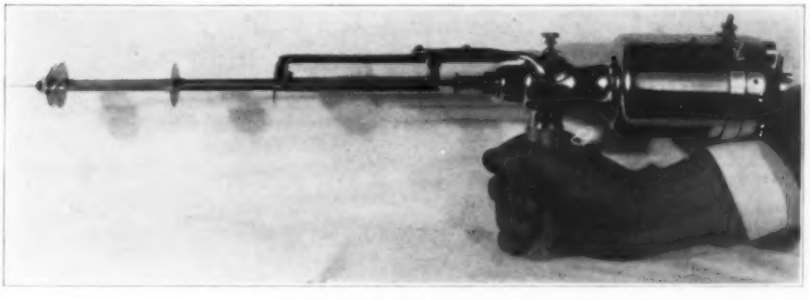

FIG. 1

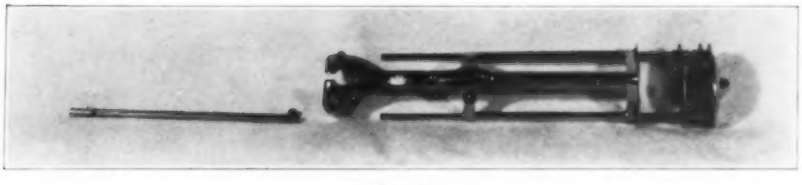

FIG. 2

The apparatus illustrated is designed to make available at low cost a motor-driven wire. Because practically every hospital has an Albee motor, this was used as a basis. The collapsing wire guide is the demountable one manufactured for use in connection with a hand drill. It has been modified so that it may be fastened with two screws to the handle which clamps about the neck of the Albee motor shell. The only other part necessary is a long axle with a set screw. This of course fits in the motor, as does the axle of the saw blades. It will be seen that this use of the Albee motor does not in any way detract from its availability for the purposes for which it was designed.

A SIMPLIFIED APPARATUS FOR THE USE OF RUSSELL TRACTION AND BUCK'S EXTENSION

BY DONALD W. HEDRICK, M.D., DETROIT, MICHIGAN

Division of Orthopaedic Surgery, Henry Ford Hospital

For the past three years it has been the practice in this Clinic to treat certain fractures of the femur in adults, and practically all fractures of the femoral shaft in children and adolescents, with Russell traction. The patient's quick relief from pain, absence of muscle spasm, the ease of control, and satisfactory alignment obtained with this method of immobilization are advantages too well known to warrant discussion.

The success of this method, however, depends entirely upon the correct application of the mechanical principles laid down in 1924 by Russell. Some difficulty was encountered by us at the outset in properly applying the necessary apparatus to the fracture bed, as well as to the ordinary bed.

In this Clinic, fracture beds have the Balkan frames built into them

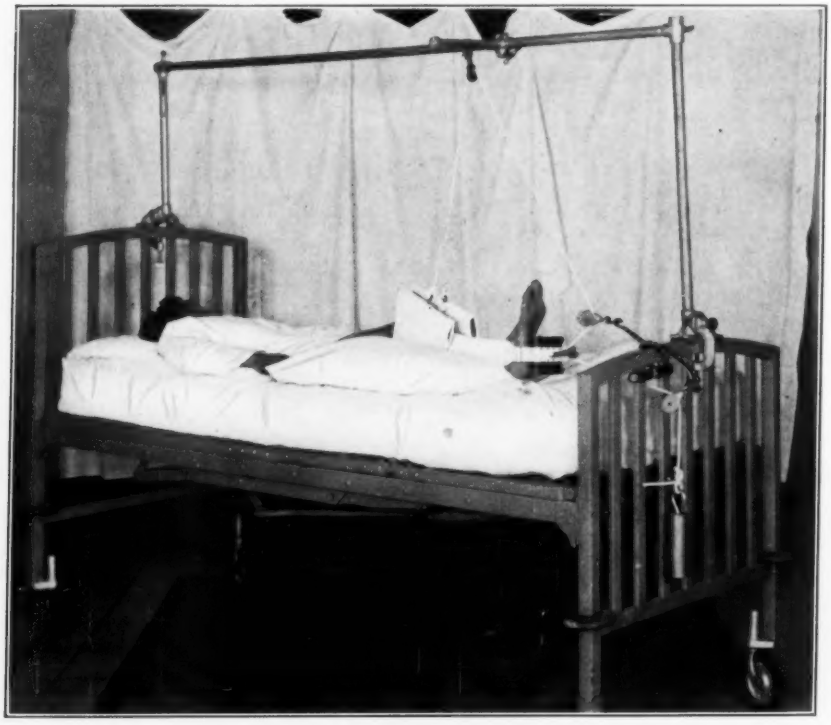

FIG. 1

View of Russell traction with Ann Arbor frame. The appliance described is used at the foot of the bed.

and pulleys at the end are attached to horizontal bars clamped to the frame. The correct angle of the foot pulleys was difficult to adjust and maintain, because the small pulley on the spreader frequently came in contact with the bar pulley, thus decreasing the traction. This was especially true when the patient was an adult of long dimensions. The apparatus described in this paper holds the pulleys far enough over the bed to eliminate much of this interference.

Most occasions for the use of Russell traction, however, arise with the treatment of fractures in children, for whom we have no fracture beds with incorporated Balkan frames. In these cases we use the so called Ann Arbor frame, which is a middle horizontal bar elevated by two vertical bars which are

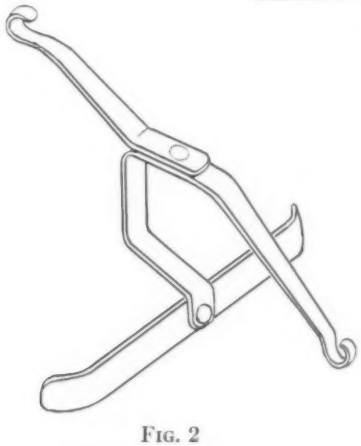

FIG. 2
Detail of the appliance.

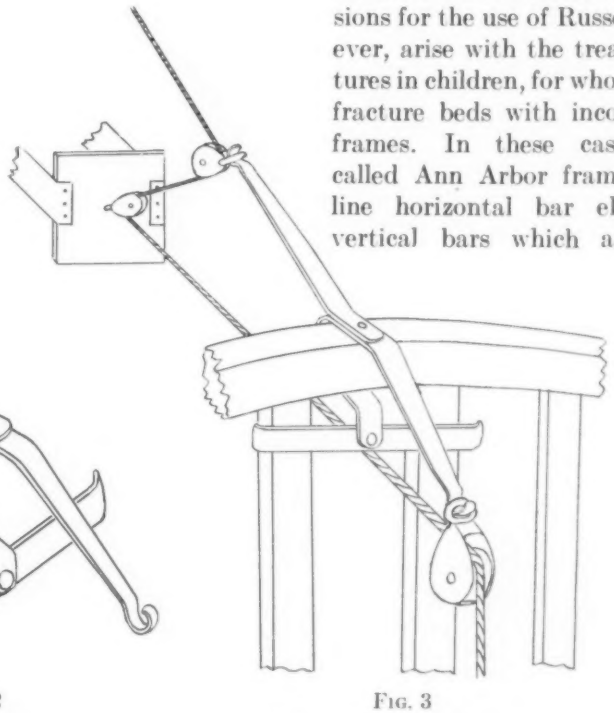

FIG. 3
Detailed sketch of apparatus attached to bed frame.

clamped to the end of the bed (Fig. 1). Pulleys are attached to the main bar or to small bars clamped at right angles to the uprights on the main bar. Short bars, clamped in this manner to round bars, slip if much tension by traction is applied; this slipping immediately changes the direction and amount of the traction. Here again the appliance described eliminates the difficulty and maintains a positive, fixed traction, the most important factor in the treatment of fractures of the long bones where displacement of the fragments exists.

The apparatus, as illustrated (Fig. 2), is made of heavy strap iron and measures eleven inches between the pulley rests. The cross piece is eight inches long. The portion which encircles the upper part of the bed frame must be large enough to slip on the end of a standard hospital bed. The lower or distal pulley holds the apparatus securely in place as soon as the traction rope is threaded through. The downward pull of the

suspended weight forces the cross piece firmly against the uprights at the end of the bed. Once in place, its position is maintained until the traction is released, so that it cannot be disturbed by the patient or others in the room (Fig. 3). The upper or proximal pulley is used as the second in the series necessary in Russell traction to produce the component of the vertical and longitudinal traction in the line of the femur.

In addition to its use in Russell traction, this appliance can be used for Buck's extension by utilizing only the lower pulley for a direct pull on the lower extremity.

The use of this apparatus greatly simplifies immobilization in the home as well as in the hospital. It is easily and quickly applied to all hospital beds and the majority of other beds. The pulleys cannot become twisted or the rope tangled. The traction cannot be disturbed.

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2. Russell, R. H.: Fracture of the Femur: A Clinical Study. British J. Surg., XI, 491, 1924.

JAMES THOMAS WATKINS

Dr. James Thomas Watkins died at his home in San Francisco on February 18, 1934, at the age of sixty-three.

Dr. Watkins was born in Baltimore, Maryland, but his youth was passed in California. He received his academic education at the University of Virginia, his medical degree from Columbia University in 1894, and spent three years in the St. Francis and New York City Hospitals. Following this, he studied orthopaedic surgery in various European centers for three years, working with Hoffa, Lange, and Lorenz. Returning home, he located in San Francisco in 1902 and at once began the practice of orthopaedic surgery. He became associated with Dr. Harry M. Sherman and received appointments on the staff of the Children's Hospital and on the teaching force of the University of California Medical School, which institutions he continued to serve until his death. His long study of European orthopaedic methods, coupled with Dr. Sherman's practical ex-

perience, made an association of great benefit to both men and lasted until the death of Dr. Sherman in 1925.

In 1903, Dr. Watkins married Eleanor Fairman Preston, of Virginia, herself a recent medical graduate; and she, with four sons, survives him.

Dr. Watkins was always interested in public service and devoted much of his time to it. After the great San Francisco earthquake and fire in 1906, he was City Health Officer from 1907 to 1910, and did much to reorganize the Health Department and to start it on the path of development to its present high state of efficiency.

During the War, in 1917 and 1918, he served as contract surgeon in the Letterman Hospital in San Francisco, but his health at that time prevented his taking more active service.

Besides being a charter member of the American College of Surgeons and elected to the American Orthopaedic Association in 1907, he helped to organize the San Francisco Orthopaedic Club and was its President in 1925, 1926, and 1927. In 1927 he also served as President of the American Orthopaedic Association at its Yosemite Valley meeting, and it was due largely to his untiring efforts that this meeting was so much enjoyed by the members. In 1933, he was elected as the first President of the Western Orthopaedic Association.

His memberships in other societies, contributions to orthopaedic literature, and consulting appointments to hospitals were numerous, and indicated his love for his specialty and his ability for hard work, in which he continued until his death.

His personal character commanded the confidence and veneration of his patients and the respect of his colleagues. He had a certain directness or bluntness of thought that was impatient with, and brushed aside, all pretense or sham in his professional work and sometimes made him enemies, but this quality was tempered by a good sense of humor and facility of expression which made his discussion of medical papers and other public utterances always free from monotony as well as scientifically worth while.

In short, the orthopaedic surgeons of the Pacific Coast feel that they have lost their leader, not only in the length of service, but in general orthopaedic knowledge and devotion to professional ideals.

News Notes

The Twenty-Ninth Congress of the Deutsche Orthopädische Gesellschaft will be held in Dortmund, October 8, 9, and 10, under the presidency of Prof. Dr. M. Brandes. The first day will be devoted to the results of research on subjects of scientific interest, the second day to the presentation of clinical material, and the third day to technique and practical demonstrations. During the Congress especial emphasis will be placed on the consideration of the condition of and the parts played by the muscles, particularly with reference to their function; epiphysitis, the different forms of osteochondritis, and allied conditions; club-foot, its forms and its treatment in different ages from the new-born to adults and relapsed cases; and the general methods of body development and training. In addition to these subjects, a large number of papers on interesting subjects will be presented by different members of the Congress.

From the Istituto Ortopedico Rizzoli in Bologna, Italy, has been received the notice of the competition for the Prize Umberto I. This prize of 3,500 lire will be assigned, according to the decision of the Provincial Council of Bologna, for "the best orthopaedic work or invention." Italian and foreign doctors may take part in this competition which will close on December 31, 1934. Application for the competition should be made to the President of the Rizzoli Institute in Bologna, who will supply the rules of the competition.

The Fourth International Congress of Radiology is to be held in Zurich and St. Moritz, Switzerland, on July 24 to 31, under the patronage of Dr. M. Pilet-Golaz, the President of the Swiss Confederation. The President of the Congress is Prof. Dr. H. R. Schinz. On July 24 through 28, the meetings will be held at the University and the Institute of Technology in Zurich, and on July 29 through 31 at St. Moritz. A large number of papers will be read by men from various countries, and a very interesting program has been arranged. All inquiries for information in regard to the meeting should be addressed to the General Secretary, Dr. Hans E. Walther, Gloriastrasse 14, Zurich.

The International Society of Radio-Biology has announced the First International Congress of Electro-Radio-Biology. This Congress will meet from September 10 to 15 in the Doges Palace at Venice, Italy, and will be presided over by His Excellency the Marquis Guglielmo Marconi, President of the Royal Academy of Italy and of the National Council of Research, and State Senator, and by His Excellency, Count Giuseppe Volpi di Misurata, State Minister and State Senator.

The object of this Congress is to invite physicists, chemists, biologists, naturalists, and physicians to discuss the biological actions of all radiations in order to coordinate the respective investigations.

For further information about the Congress, address the General Secretary, Dr. Giocondo Protti, S. Gregorio 173, Venice, Italy.

The thirteenth annual scientific and clinical session of the **American Congress of Physical Therapy** will be held in Philadelphia at the Bellevue Stratford, September 10, 11, 12, and 13.

On Wednesday evening, September 12, a joint session will be held with the Philadelphia County Medical Society and on Friday, September 14, the question of hospital teaching will be considered and clinics will be held in the leading institutions of Philadelphia.

Special features will be the scientific and technical exhibits and the small group conferences. Outstanding clinicians and teachers will present the results of the newer researches in the field, emphasizing short-wave therapy, hyperpyrexia, light therapy, remedial exercise, massage, and other interesting subjects.

For preliminary program, address American Congress of Physical Therapy, 30 North Michigan Avenue, Chicago, Illinois.

The semi-annual meeting of the **Minnesota Orthopaedic Club** was held in Minneapolis and St. Paul on Saturday, March 31, 1934.

An operative clinic was given in the morning by Dr. Wallace H. Cole, at the Shriners' Hospital, who demonstrated the operative procedure for leg lengthening. In the afternoon cases were presented by other members of the Staff. Following the dinner, Dr. C. C. Chatterton presented a group of cases of aseptic necrosis of the head of the femur, appearing a year after severe trauma, and the importance of this complication from a standpoint of industrial compensation was stressed. Dr. Cole also presented other interesting cases, particularly tibial defects following resection for osteomyelitis, and showed the results of different operative procedures.

At the business session it was decided to enlarge the Club by adding to the membership orthopaedic surgeons from North Dakota and South Dakota, and in the future the Club will be known as the Minnesota-Dakota Orthopaedic Club. Dr. Vernon Hart, of Minneapolis, Dr. H. J. Fortin and Dr. Joel C. Swanson, of Fargo, North Dakota, and Dr. G. E. Van Demark, of Sioux Falls, South Dakota, were elected to membership.

The Fourth Congress of the Polish Orthopaedic Association was held in Lwow, Poland, on November 6 and 7, 1933, under the Presidency of Prof. Wojciechowski, with an attendance of about one hundred members, representatives of the Government, and guests. Prof. Zahradniček was the official delegate of the Czechoslovakian Orthopaedic Association, of which he is president.

In the scientific meetings the two principal subjects considered were: (1) The care of the Cripple in Poland, and (2) The Mobilization of Ankylosed Joints. On the first subject, Dr. Kosinski and Dr. Cetkowski considered the question of better organization for the care of the crippled in Poland, and the discussion distinctly brought out the need for a committee on the care of cripples, and the necessity of closer contact of the Orthopaedic Association with the Government.

Prof. Gruca delivered an exhaustive report of the work in the field of arthroplasty, including the method of selection and examination of cases for operation, as well as the technique and end results. This operation was discussed by various members and guests of the Association. Short papers were also presented by other members and guests.

In executive session the following were elected as Honorary Members of the Polish Orthopaedic Association:

Prof. Vittorio Putti, Bologna, Italy.
Prof. G. Nové-Josserand, Lyon, France.
Prof. Etienne Sorrel, Paris, France.
Prof. H. L. Rocher, Bordeaux, France.
Prof. A. Maffei, Brussels, Belgium.
Prof. Maksymiljan Rutkowski, Cracow, Poland.
Prof. Hilary Schramm, Lwow, Poland.

The next Congress will be held in 1934 in Poznan, under the Presidency of Prof. Wojciechowski.

The Fifth Congress of the Pan-American Medical Association was held from March 14 to March 30, 1934, on board the Panama Pacific liner "Pennsylvania" during a cruise to the West Indies and South America. There was a large attendance, and those who participated in this Congress indicated that the group was especially interested in the expressed purpose and objective of the Pan-American Medical Association,—namely, to cultivate a better understanding between the men who are devoting their lives to the practice of medicine and surgery and the advancement of scientific knowledge throughout the twenty-two republics of this western hemisphere.

Meetings were held in the morning and part of the afternoon and evening for seven days of the cruise. The orthopaedic group met with the Sections of Roentgenology and Dermatology, which plan proved to be particularly successful. During the afternoons a general assembly was held in which papers were given on various subjects. The following papers were presented by members of the orthopaedic section:

Dr. Fred H. Albee, Presidential Address—"The Operative Treatment of Spinal Curvatures". He advocated use of the full-thickness tibial graft in its application to the spine.

Dr. Edward A. Cayo—"An Orthopaedic Surgical Engine". The engine is original, efficient, and practical. It consists of a cross-cut saw which will saw anything from a straight line to a circle a quarter of an inch in diameter, and will not puncture the soft tissues; there are also a chisel, a drill, trephine, and circular saws.

Dr. Edward L. Compere—"Tuberculosis of the Spine in Children". He called attention to the fact that the principle of fusion of the spine is almost universally accepted in this hemisphere as far as adults are concerned, but there are still many surgeons who believe that the results do not justify this procedure in children. He gave the results of treatment by spine fusion in a group of children eight years of age or younger.

Dr. Ralph K. Ghormley—"Fractures of the Humerus". Dr. Ghormley presented a review of 350 cases.

Dr. G. DeN. Hough, Jr.—"The Correction of Hip Flexion Deformity in Anterior Poliomyelitis". He presented an analysis of 168 hip flexion deformities in 130 children, with a review of the different methods of correction.

Dr. Alberto Inclan—"Extra-Articular Fusion in Hip Diseases". He reported that failure in some instances is due to a pseudarthrosis at the site of attachment of the graft in the region of the greater trochanter. He believes that the combined intra-articular and extra-articular methods of fixation are most successful.

Dr. C. L. Lowman—"Surgical Stabilization of the Paralytic Pelvis". He called attention to the three major deviations of the body segments, due to paralysis of the abdominal muscles,—namely (1) increased obliquity of the pelvis, flexing it forward on the hip joints; (2) lateral tilting from weakness of side muscles; (3) twisting of the vertebral column and formation of scoliotic deformity.

Dr. Jose Londres—"Osteogenic Exostoses". He presented a very interesting case of congenital exostoses with several hundred osteocartilaginous overgrowths.

Dr. W. R. MacAusland—"Arthroplasty of the Knee Joint". He called particular attention to the features which stood out prominently in his experience in making selection of cases for operation. He said that the indications for arthroplasty which must be considered carefully before operation include the origin and duration of the ankylosis, the age of the patient, the condition of the skin, musculature, and bone, and, finally, the general health of the patient; he considers the last factor very important. He always uses an operative technique which assures the maintenance of stability, for stability must not be sacrificed in order to obtain complete motion.

Dr. William Nachlas—"Pseudo Angina Pectoris Originating in the Cervical Spine". He stated that angina pectoris is a diagnosis based on symptoms, and that there is a pathological condition of the cervical spine which produces the same symptoms.

Dr. Alfred A. Richman—"The Conn Fixation Method for Open Reduction of Fractures with Modifications".

Dr. Earl D. McBride—"Permanent Disability from Deformity in Fractured Bone Shafts".

Dr. J. W. Sever—"Obstetrical Paralysis".

Dr. Ortiz Tirado—"The Use of the Bone Graft in Surgery in Mexico".

Papers read by members of the Orthopaedic Section before the general assembly at the afternoon sessions included:

Dr. Ralph K. Ghormley—"Low Back Pain".

Dr. Fred Albee—"Treatment of Advanced Tubercular Joint Disease".

Dr. Edward L. Compere—"Metabolism of Calcium and Phosphorus in Health and Disease".

The Forty-Eighth Annual Meeting of the American Orthopaedic Association was held at The Mayo Clinic, Rochester, Minnesota, June 6 to 9, under the presidency of Dr. Melvin S. Henderson. Dr. Murk Jansen, of Leiden, Holland, and Mr. W. Rowley Bristow, of London, England, were present as guests of the Association.

The morning of the first day was devoted to the presentation of cases and clinical demonstrations at St. Mary's Hospital.

The sessions on June 7 and 8 and the morning of June 9 were held in Plummer Hall and papers of special scientific interest were presented by the members and guests.

The program as arranged by the Committee was as follows:

THURSDAY, JUNE 7

Morning Session

Symposium on the Open Treatment of Congenital Dislocation of the Hip:

Selection of Cases for Operation.

Dr. A. H. Freiberg, Cincinnati, Ohio.

Operative Technique:

Treatment Based on Physiology of Congenital Dislocation of the Hip.

Dr. Steele F. Stewart, Los Angeles, California.

The Operative Technique with Some of Its Complications.

Dr. Wallace H. Cole, St. Paul, Minnesota.

Late and End Results.

Dr. F. C. Kidner, Detroit, Michigan.

Dr. B. P. Farrell, New York, N. Y.

Afternoon Session

Symposium on the Open Treatment of Congenital Dislocation of the Hip (Continued):

Plastic Operations:

Dr. Frank D. Dickson, Kansas City, Missouri.

Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

A Shelving Operation by Means of Peg Graft from Tibia.

Dr. D. B. Phemister, Chicago, Illinois.

Dr. E. L. Compere, Chicago, Illinois (by invitation).

Some Observations on Results of Shelf Operations in Congenital Dislocation of the Hip, Covering a period of Thirteen Years. Report of Twenty-Four Cases.

Dr. F. R. Ober, Boston, Massachusetts.

Neck or Shaft Plastic:

Schanz Osteotomy in Irreducible Congenital Dislocation of the Hip.

Dr. F. J. Gaenslen, Milwaukee, Wisconsin.

FRIDAY, JUNE 8

Morning Session

Treatment of Fractures of the Os Calcis.
Dr. H. R. Conn, Akron, Ohio.
President's Address: Leadership in Orthopaedic Surgery.
Dr. M. S. Henderson, Rochester, Minnesota.
Traumatic Dislocation of the Tendon of the Long Head of the Biceps Brachii.
Dr. LeRoy C. Abbott, San Francisco, California.
Internal Derangements of the Knee.
Mr. W. Rowley Bristow, London, England.
The Treatment of Acute Purulent Arthritis by Joint Washing.
Dr. Hugh Jones, Los Angeles, California.
Treatment and End Results of Adolescent Epiphyseolysis of the Upper End of the Femur.
Dr. P. D. Wilson, New York, N. Y.
Pinching of the Ligamentum Teres of the Hip.
Dr. Murk Jansen, Leiden, Holland.

Afternoon Session

The Treatment of Legg-Calvé-Perthes Disease without Weight-Bearing.
Dr. Murray S. Danforth, Providence, Rhode Island.
Tendon Fixation in Infantile Paralysis—Late Results.
Dr. W. E. Gallie, Toronto, Canada.
Traumatic Separation of the Medial Epicondyle of the Humerus in Adolescence.
Dr. John Dunlop, Pasadena, California.
Endothelial Myeloma; Analysis of Cases.
Dr. Willis C. Campbell, Memphis, Tennessee.
X-Ray Studies of the Diaphragm in Children. Its Correlation with Body Mechanics.
Dr. Lloyd T. Brown, Boston, Massachusetts.

SATURDAY, JUNE 9

Morning Session

Papers by members of the Staff of The Mayo Clinic:

Lymphoedema.
Dr. E. V. Allen
Roentgen Visualization of the Vessels of the Extremities.
Dr. N. W. Barker
Medical and Orthopaedic Aspects of Arteriovenous Fistulae.
Dr. B. T. Horton
Abnormalities of the Osseous System Associated with Anaemia and Splenomegaly.
Dr. H. Z. Giffin
Dr. J. D. Camp
Dental Diagnosis—Its Relation to Mineral Metabolism.
Dr. B. S. Gardner
Dicalcium Phosphates in Bone Metabolism—An Experimental Study.
Dr. G. M. Higgins
The Curability of Malignant Tumors of the Upper Jaw and Antrum.
Dr. G. B. New
Intraspinal Tumors with Orthopaedic Manifestations.
Dr. H. L. Parker
Studies of Cataphoresis of Streptococci.
Dr. E. C. Rosenow

The Annual Dinner was held on Friday evening, June 8, at the Hotel Kahler.

At the Executive Session held on June 9 the following nine orthopaedic surgeons were elected to membership:

Edward L. Compere, M.D., Chicago, Illinois.
Richard B. Dillehunt, M.D., Portland, Oregon.
John G. Kuhns, M.D., Boston, Massachusetts.
Toufick Nicola, M.D., New York, N. Y.
William A. Rogers, M.D., Boston, Massachusetts.
George W. VanGorder, M.D., Boston, Massachusetts.
George W. Wagoner, M.D., Philadelphia, Pennsylvania.
J. Warren White, M.D., Greenville, South Carolina.
Isadore Zadek, M.D., New York, N. Y.

And the following were elected Corresponding Members of the Association:

Mr. W. Rowley Bristow, London, England.
Mr. W. A. Cochrane, Edinburgh, Scotland.
Mr. Naughton Dunn, Birmingham, England.
Dr. Bedřich Frejka, Brno, Czechoslovakia.
Dr. Charles Lasserre, Bordeaux, France.
Mr. T. P. McMurray, Liverpool, England.
Dr. M. zur Verth, Hamburg, Germany.

The following officers were elected for the ensuing year:

President: DeForest P. Willard, M.D., Philadelphia, Pennsylvania.
President-Elect: Frederick J. Gaenslen, M.D., Milwaukee, Wisconsin.
Vice-President: Benjamin P. Farrell, M.D., New York, N. Y.
Treasurer: John L. Porter, M.D., Evanston, Illinois.
Secretary: Ralph K. Ghormley, M.D., Rochester, Minnesota.
Editor: E. G. Brackett, M.D., Boston, Massachusetts.
Member of Executive Committee: Melvin S. Henderson, M.D., Rochester, Minnesota.
Member of Membership Committee: John C. Wilson, M.D., Los Angeles, California.
Member of Program Committee: Rexford L. Diveley, M.D., Kansas City, Missouri.

Delegates to the American College of Surgeons: D. B. Phemister, M.D., Chicago, Illinois; David Silver, M.D., Pittsburgh, Pennsylvania; William B. Owen, M.D., Louisville, Kentucky.

Delegates to the American Board of Orthopaedic Surgeons: Philip D. Wilson, M.D., New York, N. Y.; W. B. Carrell, M.D., Dallas, Texas. Alternate: Oscar Lee Miller, M.D., Charlotte, North Carolina.

Delegate to the Congress of Physicians and Surgeons: J. Torrance Rugh, M.D., Philadelphia, Pennsylvania. Alternate: Robert D. Schrock, M.D., Omaha, Nebraska.

The next meeting of the Association will be held in Philadelphia, Pennsylvania, under the presidency of Dr. DeForest P. Willard.

UNDERGRADUATE INSTRUCTION IN ORTHOPAEDIC SURGERY

Report of Committee Appointed by the American Orthopaedic Association*

A committee of five teachers of professorial rank was appointed by the President of the American Orthopaedic Association, after its Annual Meeting in 1932, and was instructed to review the present undergraduate instruction in Orthopaedic Surgery in the medical schools throughout the United States and Canada and to make suggestions as to the desirable scope and nature of such instruction. This Committee has submitted its report.

By means of a questionnaire sent to the heads of Departments of Orthopaedic Surgery in the Class A medical schools of the United States and Canada, the following epitomized statistical information was obtained from 91.5 per cent. of the replies.

A. Hours of instruction:

1. The number of whole class (chiefly didactic) hours of instruction at present being devoted to Orthopaedic Surgery in the different medical schools during the four undergraduate years is found to vary from eight to ninety.

2. The number of clinical (section work) hours is found to vary from twelve to 150.

B. Subjects in which instruction is being given by Departments of Orthopaedic Surgery are listed in order of frequency:

1. Tuberculosis of the bones and joints
2. Congenital defects and lesions
3. Anterior poliomyelitis
4. Scoliosis
5. Faulty statics, chiefly foot strain
6. Rickets and allied diseases (scurvy, osteomalacia, chondrodystrophies, osteogenesis imperfecta, etc.)
7. Spastic palsy, obstetrical paralysis, Volkmann's contracture, etc.
8. Nutritional growth disturbances, osteochondritis, epiphysitis, etc.
9. Fractures and dislocations (in whole or in part)
10. Osteomyelitis (in whole or in part)
11. Mechanical derangement of joints (chiefly knee)
12. Acute and subacute infectious arthritis
13. Chronic arthritis (in whole or in part)
14. Traumatic joint lesions (chiefly industrial)
15. Body mechanics and posture
16. Methods of examination of joints and of diagnosis
17. Neoplasms of bone (in whole or in part)
18. Operative technique
19. Traumatic arthritis
20. Reaction of joints to various irritations
21. Lesions and affections of bursae
22. Physical therapy
23. Orthopaedic pathology
24. Ankylosis
25. Normal and surgical joint anatomy
26. Back pain

*Presented at the Annual Meeting of the American Orthopaedic Association at Rochester, Minnesota, June 7, 1934, by Robert B. Osgood, M.D., Chairman.

27. Luetic disease of bones and joints
28. The history of orthopaedic surgery
29. Apparatus, plaster-of-Paris technique, etc.
30. Diseases of the vascular system
31. Diseases of the neuromuscular system
32. Prevention of deformity
33. Correction of deformity
34. Myositis
35. Scar contractures
36. The relation of orthopaedic surgery to industry
37. Laboratory findings
38. Lesions of tendons
39. The physiology of the bones and joints
40. Orthopaedic complications
41. The principles of orthopaedic surgery and the etiology of deformities.

In about seventy per cent. of the replies, it was stated that, in the instruction given, greater emphasis is being placed upon the detail of examination and diagnosis than upon treatment.

About twenty-six per cent. replied that examination and diagnosis and treatment received about equal emphasis in the instruction given. Two did not answer the question, but in no reply was it stated that more emphasis was placed upon treatment than upon detail of examination and diagnosis. This finding the Committee feels represents a fortunate situation.

Coordinated or overlapping instruction is being given by other departments than the Department of Orthopaedic Surgery in over fifty per cent. of the medical schools. The following subjects are listed in order of the frequency in which such instruction is being given:

1. Fractures and dislocations
2. Chronic arthritis
3. Osteomyelitis
4. Anterior poliomyelitis, neurology or neurosurgery
5. Neoplasms of bone
6. Rickets and allied conditions
7. Vascular diseases
8. Tuberculosis of the bones and joints
9. Birth injuries
10. Bone and joint pathology
11. Physical therapy
12. Septic joints.

A certain amount of overlapping instruction is probably inevitable and may be occasionally advisable. Some of the replies suggest that the overlap is so broad as to at least waste the student's time if it does not actually confuse him.

COMMENT

It is evident that the scope of Orthopaedic Surgery has broadened along with the scope of instruction in General Surgery and Medicine and in some of the other special branches. Those in charge of the curricula of medical schools are placing important responsibilities on Departments of Orthopaedic Surgery.

An analysis of the replies reveals the fact that at present nearly all Departments of Orthopaedic Surgery are responsible for the major instruction in:

1. Congenital defects, lesions, and diseases of the bones, joints, and muscles
2. Tuberculosis of the bones and joints

3. Anterior poliomyelitis (after the acute stage)
4. Scoliosis
5. Faulty statics and faulty weight-bearing
6. The deformities of rickets and certain of the growth disturbances of the skeleton
7. The locomotor difficulties of cerebral palsy, obstetrical paralysis, Volkmann's contracture, etc.

It is interesting also to find that more than fifty per cent. of the Departments of Orthopaedic Surgery are responsible for instruction (either in whole or in part) in the following subjects:

Traumatic joint lesions	(72 per cent.)
Fractures and dislocations	(68 per cent.)
Osteomyelitis	(68 per cent.)
Mechanical derangements of joints	(61 per cent.)
Infectious arthritis (acute or subacute)	(52 per cent.)
Chronic arthritis	(52 per cent.)

It was suggested in the original motion, which resulted in the appointment of this Committee instructed to survey and report upon the status of undergraduate instruction in Orthopaedic Surgery, that an attempt be made to outline an ideal course of undergraduate instruction in Orthopaedic Surgery.

The Committee feels that the differences in organization of Departments of Orthopaedic Surgery and in the interests and training of the local general surgical and orthopaedic personnel in the various medical schools make it undesirable, and indeed futile, for the Committee to attempt to standardize or even to outline in any rigid way such an ideal course. The Committee has deemed it more profitable to call attention to the findings of the questionnaire which indicate the present situation, and to list the subjects and conditions in which, in its opinion, undergraduate instruction might well be given in whole or in part by a Department of Orthopaedic Surgery. The subjects and conditions have been listed in a rough order of sequence and importance of instruction:

1. Functional and surgical anatomy of the bony skeleton and locomotor system and normal body mechanics. (In cooperation and coördination with the Department of Anatomy and perhaps the Department of Physiology.)
2. Methods of examination of bones, joints, bursae, muscles, and closely associated structures and systems. This instruction should constitute an integral part of the course in Physical Diagnosis now generally supervised by the Departments of General Medicine and Roentgenology.
3. The diagnosis, pathology, and etiology, together with the prevention, "first-aid" treatment, and the general principles of treatment of defects, lesions, and diseases of the bones, joints, bursae, muscles, tendons, and of their vascular, nervous, and sometimes visceral mechanisms. (In cooperation and coördination with the Departments of Surgery, Medicine, Pediatrics, Neurology, Pathology, and possibly Bacteriology.)
4. The scope and general principles of Orthopaedic Surgery and its relation to industry and workmen's compensation.
5. The scope and general principles of physical therapy and the application of the simpler methods of its administration.

C. Number of hours of Orthopaedic instruction during the four-year course:

1. Whole class exercises.

The Committee is of the opinion that a certain number of whole-class exercises may be advantageously employed in an explanatory manner during the four years, in order to indicate the scope and general principles of the specialty. From a review of the findings of the questionnaire, the Committee came to the conclusion that in several of the leading medical schools

approximately twenty-four such exercises of an hour's duration were being profitably employed in this manner during the four years, the majority of the hours being assigned to the third year. In about sixty-eight per cent. of the medical schools, Departments of Orthopaedic Surgery are being held responsible for a part of or for the entire instruction in fractures and dislocations. Where the entire instruction in these subjects is to be given by a Department of Orthopaedic Surgery, the Committee suggests that twelve more whole-class exercises should be provided to cover the subjects of Fractures and Dislocations.

2. Clinical instruction in sections.

The Committee is of the opinion that clinical instruction to small sections, preferably of not more than twelve students, should be given (1) by the Department of Orthopaedic Surgery in the wards and out-patient departments of the teaching hospitals and (2) by conferences and ward rounds in conjunction with the surgical and medical staffs. Where the material is ample and the staff of teachers is sufficiently large, the Committee suggests that each student should receive during his four years not less than seventy, and not more than one hundred, hours of such instruction. If this clinical instruction is to include the subject of Fractures and Dislocations, and the Department of Orthopaedic Surgery is held responsible for the entire undergraduate instruction, perhaps thirty-five to fifty more hours of instruction per student should be added.

D. Organization of Departments of Orthopaedic Surgery:

In many of the leading medical schools, Departments of Orthopaedic Surgery are evidently accepting in an entirely satisfactory manner the large responsibilities which have been placed upon them by curricula committees. In other schools these ideals of usefulness are not being completely realized, perhaps because the Departments have lacked any opportunity to attempt such realization and perhaps because the Departments have lacked the ability to take advantage of the opportunity when it has been offered.

The Committee holds no fixed opinion as to whether a Department of Orthopaedic Surgery is likely to function best as an entirely independent department or as one of the sections of the Department of Surgery. Excellent undergraduate instruction in Orthopaedic Surgery is at present being given by departments which function under each one of these plans of organization, and both plans have their advantages and disadvantages.

The replies to the questionnaire indicate that over eighty per cent. of the Departments of Orthopaedic Surgery are functioning as actually or practically independent departments. The Committee feels that Orthopaedic Surgery merits as favorable a consideration in this respect as any other of the special branches of surgery.

The organization of some medical schools provides for a single head for all the major departments. If such an organization obtains, it is obviously advisable that a "chief" should keep in closest touch with all the special departments under him and be freely accessible to those in charge of these departments. It is still more important that in schools where autonomous special departments exist, there should be close coordination of teaching between the major departments of medicine, surgery, and pediatrics and the special departments. This is peculiarly true in relation to Orthopaedic Surgery since, in general, this branch of surgery may be said to deal more with the principles of the preservation of function in the various locomotor systems than with pathological conditions arising in a limited anatomical field. There is quite as much danger of the special departments locking themselves within their own walls as of the major

departments failing to knock at the gates of the special departments. Broad highways should extend from the suburbs to the main city. These roads should be built to stand heavy travel by both business and pleasure cars. There should be two-way traffic and the lights should be continuously green.

GEORGE E. BENNETT, M.D., Professor of Orthopaedic Surgery, Johns Hopkins University, Baltimore, Maryland

ARTHUR KRIDA, M.D., Professor of Orthopaedic Surgery, Bellevue Medical School, New York, N. Y.

DALLAS B. PHEMISTER, M.D., Professor of Surgery, University of Chicago, Chicago, Illinois

J. TORRANCE RUGH, M.D., Professor of Orthopaedic Surgery, Jefferson Medical College, Philadelphia, Pennsylvania

ROBERT B. OSGOOD, M.D., *Chairman*, Professor of Orthopaedic Surgery (Emeritus), Harvard University, Boston, Massachusetts

Current Literature

THE LIFE OF SIR ROBERT JONES. By Frederick Watson. London, Hodder & Stoughton, Ltd., 1934. Price 12 shillings, 6 pence.

The appearance of this book has been eagerly awaited in several countries by those who have had an opportunity to know Sir Robert Jones and who have been in touch with his many activities during some period of his life. Not only professionally, but individually he has been so much of an international character that this book will be of international interest.

Probably no one is so well fitted or so well equipped with material as is Mr. Watson to give to the world the story of so illustrious a surgeon and so remarkable a man as Sir Robert Jones. His relationship, which gave to him so intimate a touch, made his task a labor of love and this is evident throughout the book in the use of material which has been available to him because of his family ties. He has used it wisely and has painted the picture with a bold and international stroke which is essential in portraying the likeness of this man who has transcended all national boundaries in his interests and accomplishments. He has told the story so skillfully that one can follow the growth of this unusual man from the beginning. Not often, in a biography, can one follow so intimately the life of a man as in this book and particularly during the early and formative years. Mr. Watson has skillfully traced the influence of Sir Robert's inheritance and of his early environment on the later development of the man. He has shown to the world with an accuracy and fairness, which are a great satisfaction, the characteristics and remarkable traits of character of Sir Robert Jones and particularly the very great humanitarianism which his friends have known and have had the opportunity of seeing in their closer contact with him. Mr. Watson has also shown more than this. He has taken us into the period of Sir Robert's ancestors, and has traced their guiding influence on his character, as well as the shaping of his life through his own management of his early years, and the effect of these factors on his later and mature life. One can trace the general unfolding of his character and traits and their expression in the daily experiences throughout his entire life, and especially their appearance in the time of the larger responsibilities which came to him and to the demands of which he responded with the same capacity and human understanding.

Sir Robert early had the vision to recognize not only the needs of the cripple, but his right to be given a place in the normal community and to be placed in the same plane of responsibility with his normal mates. However, it was not simply the straight thinking of the surgeon, but also the finer instincts of fairness and justice in the man that called him into this field of endeavor and led him to his accomplishments, while he was still so much alone in this difficult path of progress.

His War record was but the continuation, on a tremendous scale, of his methods and of the success which is evident is each period of his early career. Mr. Watson has shown how in later years, when the strenuous work of the World War was over, his activities were in no way abated; and how he set himself to work to make permanent and available to all of his countrymen the information which had been gathered during these years, and to apply to civil life all that vast experience which had been gained during that time. After five years of such endeavor, responsibility, and success, only the broadest field of work could have satisfied him; and the task which he accomplished during this Post-War period in disseminating his information and making it available for the continued demands of civil life was no less in its magnitude, nor was it less important in its benefit to his fellow men.

After reading the book his friends will realize more keenly their loss and will feel still more deeply their affection for the man.

GELENKSTEIFEN UND GELENKPLASTIK (Stiff Joints and Arthroplasty), Part I. By Dr. Erwin Payr. Berlin, Julius Springer, 1934. 120 marks.

In careful, accurate, and thorough fashion the author compiles from his vast experience those observations, views, and conclusions which influence the selection of cases for arthroplasty. "In the correct choice of cases lies for the greatest part the secret of success." Originally, apparently the book was intended to include indications and technique. However, as the author compiled his material, the implications of the problem necessitated, for the sake of clearness and completeness, the inclusion of at least the high points of the normal and pathological biology of joints. The latter, presented in restrained but encyclopaedic chapters, occupies so much space that technique is left for a future second volume.

The book represents the first attempt at an all-inclusive presentation of the problems of arthroplasty. Despite the vastness of the field which the author covers and the inclusion of a tremendous amount of primarily German bibliographical material, it is everywhere a personal document of a critical student and an experienced practical surgeon. Individual workers in the various special fields of pathology and kinesiology might possibly wish that their subjects had been treated in more detail. But to the intelligent surgeon who studies this monumental work, it will be a matter of wonder, as well as satisfaction, that all the fields pertinent to the problems of arthroplasty could have been presented by one man so succinctly and pointedly.

The size of the volume, 880 pages, will probably necessitate its being used primarily as a source of reference and this is rather a pity, since the material contained is so very usable.

THE SHOULDER: RUPTURE OF THE SUPRASPINATUS TENDON AND OTHER LESIONS IN OR ABOUT THE SUBACROMIAL BURSA. By E. A. Codman. Privately printed by Thomas Todd Co., Boston, 1934.

A notable book, this of Codman's, and an important one.

It represents the fruit of thirty years' observation since he first betook himself to the study of shoulders; it represents much intensive work through the years, and, at the end, five years of study and collation of data, and ordering of observations and conclusions.

No one else has done as much as he has in this field and the data here given must be accepted as authoritative.

This volume is destined to take a place with such works as that of Poland on epiphyses, Poirier and Cuneo on bursae, Dwight on anomalies of bones of the hand and foot,—to become one of the books on special subjects with which one must perforce be familiar in order to qualify for discussion of the subject in hand.

Herein is the value of the book, and he who wishes to know of the pathology and course, the diagnosis and treatment, of these conditions, must go to this book.

From a *clinical* point of view the book may be differed with in spots, inasmuch as the graver lesions here emphasized are really rare; but this matters little, as the book will hardly be widely read by general practitioners.

Stiff shoulders, still classified as bursitis, will continue in large numbers to do well with ether manipulation and physiotherapy, or (more slowly) without either.

Now, however, we can have a clearer idea of underlying causes, can segregate and often diagnose the cases with graver lesions,—those calling for surgery.

Suture of supraspinatus tendons will always be resorted to only after grave consideration, until our diagnosis matches our knowledge better, though the results are sometimes admirable.

One has the feeling that open exploration should be done *only* for special reason, and that tapping or submuscular drainage, particularly in acute cases, deserves a larger place than that accorded it here.

But all this is by the way, and the only real word is that of tribute to an unusual record of research.

The curiously personal challenge of the foreword and epilogue of this book cannot be ignored.

Here we have the record of a man of great ability and high ideals.

The establishment of the Registry of Bone Sarcoma and the long, dogged fight for evaluation of our work in surgery in terms of end-result study are the things for which Codman will be remembered as one of the outstanding personal influences of our time.

Every reformer, to be good, must have a smear of the fanatic about him, must be a bit intolerant, not only of opposition but of what seems to him half-hearted support.

"Leave all and follow me" was ever a hard commandment to follow.

As the world goes, it is given to few of us to consecrate ourselves to that uplift in which we none the less believe.

DIE WIRBELGELENKE. DIE RÖNTGENOLOGISCHE DARSTELLBARKEIT IHRER KRANKHAFTEN VERÄNDERUNGEN UND IHRE BEZIEHUNGEN ZU DEN VERSCHIEDENEN ERKRANKUNGEN DER WIRBELSÄULE. ZUGLEICH EIN BEITRAG ZUR PATHOLOGIE UND KLINIK DER GESAMTEN WIRBELSÄULE. Beilageheft zur *Zeitschrift für Orthopädische Chirurgie*, Bd. 61. By Priv.-Doz. Dr. Max Lange. Stuttgart, Ferdinand Enke, 1934. 7 marks.

An extensive study of the small articulations of the spine must be considered an important contribution to our knowledge of those structures. In this volume the author demonstrates, by description and illustration, the pathological changes which may be noted in the small joints, in connection with various diseases and deformities.

The anatomy of the normal vertebrae is presented as it appears on direct and on röntgenographic examination. This, of course, includes the variations at different levels of the spine and also directions for obtaining a proper view of joints in the x-ray photograph.

Attention is directed chiefly to the changes in the interarticular processes, as seen in different forms of arthritis, in scoliosis, kyphosis, lordosis, and fractures of the spine. A very important feature is the critical analysis of the changes seen in the lumbosacral region, and the correlation of these changes with low back pain.

The verbal descriptions are adequately supplemented by clear instructive illustrations,—diagrams, photographs of pathological specimens, and roentgenograms.

This work may well be said to fill an important gap in our knowledge of diseases of the spine.

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS. By John Albert Key, B.S., M.D., and H. Earle Conwell, M.D., F.A.C.S. St. Louis, The C. V. Mosby Company, 1934. $15.00.

The two authors of this volume of 1164 pages are well fitted to collaborate. Key has been able to make important contributions to bone and joint surgery largely through personally conducted research. Conwell for many years has successfully solved the practical problems of the fractures, dislocations, and sprains seen in large industrial hospitals, and often by original methods. Both authors are unhampered by tradition, are clear thinkers, possessing imagination. They have had wide clinical experience and strive to tell "the truth, the whole truth, and nothing but the truth". Whenever their own practice does not fit them to speak with authority, they have called in able surgeons to help them,—as in the chapter on "Fractures of the Skull and Brain Trauma" by Dr. Charles Dowman and in the chapter on "Fractures of the Jaw and the Bones of the Face" by Dr. J. B. Brown.

Excellent reviews of the surgical anatomy precede the discussions of the fractures and dislocations of the different skeletal regions.

The allotment of space seems to be well proportioned to the clinical importance of the subjects under consideration.

Recognizing the increasing importance of industrial accidents with their medicolegal connotations, they have added special chapters on "The Workmen's Compensation Law Affecting Fracture Cases" and on "The Medicolegal Aspects of Fracture Cases". The book is divided into Part I, "General Considerations", and Part II, "Diagnosis and Treatment of Specific Injuries". The illustrations are very numerous, the number exceeding the pages of descriptive text, but they are well chosen and supplement the text in a most helpful manner. The legends are full and unusually explanatory.

Key and Conwell have not simply written one more book on fractures, but, after a wide review of methods, have judiciously evaluated results and with a refreshing frankness have stated their conclusions based on personal experience. The authors seem to have fulfilled the purpose, stated in their preface, of writing a book for the student, the general practitioner, and the surgeon as a practical working guide in the management of fractures, dislocations, and sprains.

L'Enfant. By Léon Dieulafé et Raymond Dieulafé. Paris, J.-B. Baillière et Fils, 1933.

This work represents a most thorough study of practically every phase in the development of the child, and each part is given in the most accurate detail. The morphology, anatomy, and growth are considered in each period of the child's development, and the authors have combined the results of their research with very abundant data from the literature on anatomy, anthropology, medicine, and surgery. This vast amount of data is so well tabulated and arranged that the information given on any particular phase of the subject is easily found, which adds greatly to the value of this book for reference and for study.

The development of the child is first followed from the standpoint of the normal, and, from this basis, the factors are given which produce abnormal or pathological growth. A chapter each is devoted to the skeleton with the joints, the head, and the cavities of the face, the thorax, and the abdomen.

By the study of this book, the physician is better equipped to so guide the development of the child that the individual variations in the constitutional elements may be adapted to the functional demands and the capacity of the individual organism may not be overtaxed. The book is invaluable, particularly for the general practitioner and pediatrician.

Corrective Physical Education. By Josephine Langworthy Rathbone. Philadelphia, W. B. Saunders Company, 1934. $2.50.

On reading this text-book for students of physical education, the somewhat striking title is justified. The book is written for Normal School students and for those graduates who wish to supplement what they obtained in student days. A fundamental knowledge of anatomy and physiology must be presupposed.

This book emphasizes prevention of bodily disabilities and diseases rather than cure. In stressing prevention, good descriptions of a number of orthopaedic and general diseases and disabilities are given and general principles of gymnastic treatment, rather than complete lists of exercises, are outlined. Fundamental principles of physical training are thoroughly portrayed. Postures are defined in anatomical terms and bone-and-joint, muscle, and neuromuscular relationships in standing, sitting, and walking are studied. Human anatomy from the standpoint of kinesiology, neuromuscular fatigue, and faulty postures effected by mechanical abnormalities of the spine are discussed and groups of exercises are given. The author rightly places upon the physician the responsibility of the care of individuals, but shows where the physical trainer may cooperate.

The book contains a full glossary, bibliography, and index. The illustrations include some striking reproductions of classical statuary and a liberal use of so called "ants". The latter are effective when used in conjunction with the description of specific exercises.

This text-book should be of particular value to the student of physical education in that it bridges the gap between the fundamental studies of physical education and the place which systematic and special exercise holds in human therapy. These fundamental principles of physical education should be better understood by physicians, and for those who wish to study in this field the book is valuable. However, for the physician, and especially the orthopaedic surgeon, who wishes lists of specific exercises for definite pathological conditions, the book will be found lacking.

RHEUMATISMUS. By Prof. Dr. Wolfgang H. Veil. Stuttgart, Ferdinand Enke, 1934. 2 marks.

In this booklet of thirty-six pages, a supplement to *Zeitschrift für Orthopädische Chirurgie* (60. Band), the author discusses rheumatism as a generalized disease. A critical analysis is made of the more important theories regarding the etiology, and a large number of clinical disease pictures are brought into close relationship with rheumatism. From the standpoint of social hygiene and constitutional hygiene, the importance of this condition is emphasized by the statement that approximately one-tenth of all patients and invalids are afflicted with rheumatism. Regarding treatment, emphasis is placed on prophylaxis during early life.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Boletines de la Sociedad de Cirugía de Rosario, I, Núm. 1, 1934.

Bulletin of the National Tuberculosis Association (New York), XX, No. 5, 1934.

Medico-Surgical Suggestions (Madras, India), III, Nos. 1–3, 1934.

La Tribuna Médica (Havana), VIII, No. 214–215, 1934.

Universidad Autónoma de Barcelona. Facultad de Medicina: Organización, Régimen de Estudios, Programa de Cursos para el Año 1933–1934.

ON INJURIES OF THE MENISCI OF THE KNEE-JOINT. Oscar Aleman and Sten Friberg. *Acta Chir. Scandinavica*, LXXIV, 319, 1934.

After reviewing 186 cases of injury of the semilunar cartilages, the writers present this old subject in a refreshing way. There were 160 medial and twenty-six lateral cartilage injuries. The material was from a military hospital and, therefore, not suitable for statistical study other than tabulation of the types of injury. The writers are skeptical of the existence of the hypermobile cartilage. They do include superficial rupture and splitting into layers, however. There were three cysts of lateral cartilages.

The mechanism, clinical findings, and diagnosis are carefully studied. Rupture of the medial cartilage must be differentiated from chondromalacia patellae, which closely simulates it. Lesions of the lateral cartilage are more easily diagnosed than those of the medial. Localized swelling over the lateral joint line, just in front of the collateral ligament, is a very important sign.

All of their diagnoses are confirmed by operation. If no definite tear is found, the cartilage is not removed. An anterior parapatellar incision is used, and frequently in the case of the lateral cartilages and occasionally in the medial cartilages a posterior incision is also used. The authors prefer to leave in a rim of cartilage rather than to take out the whole thing, and have even devised a knife for splitting it longitudinally. A "ring-knife" is used on the medial cartilages much as a tonsil snare is used by some surgeons in America for cutting the posterior end. An Esmarch bandage is not used in cases of patients over forty-five years for fear of thrombosis. The knee joint is kept immobilized for eight or ten days and full use is allowed in four or six weeks. The follow-up examinations are tabulated.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Osteochondritis Dissecans Capituli Humeri. N. Aage Nielsen. *Acta Orthop. Scandinavica*, IV, 307, 1933.

This monographic article of 140 pages reviews the literature of joint mice, beginning with Paré, and then analyzes the writer's cases in detail. He has observed 133 patients with osteochondritis dissecans of the capitellum, a total of 168 elbows of which fifty-six were operated upon. Roentgenographic examination of 1000 males taken at random from the vicinity showed an incidence of this malady of four and nine-tenths per cent. From this wealth of material the writer arrives at numerous conclusions, some of which are as follows:

Osteochondritis dissecans capituli humeri is almost entirely limited to males, and is most common among those engaged in physical work. Trauma plays no definite etiological rôle, and there is no evidence to support the theories that endocrine disturbances, nervous disorders, or rickets are responsible. There is a striking similarity between this disease and coxa plana, Köhler's, and Kienböck's diseases. It is an aseptic bone necrosis occurring at a definite location, often bilaterally symmetrical, at a certain period in the development of the individual, almost always between the ages of thirteen and seventeen, and with a definite relation to sex and heredity. Subjective symptoms are not always present. Operative removal of free bodies is indicated when they cause pain or disability, but good results cannot be ascribed solely to the operative procedure, for symptoms may disappear with spontaneous healing. There is no justification for the theory that operation lessens the extent of the deforming arthropathy.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

The First Stages of Coxa Plana. Henning Waldenström. *Acta Orthop. Scandinavica*, V, 1, 1934.

After twenty-five years of writing on the subject of coxa plana, Waldenström contributes this study of the earliest stages of coxa plana. He divides the development of the lesion into a pre-coxa-plana stage, the initial stage lasting six months to a year, and the succeeding stage of fragmentation, lasting two to three years. In his studies are included pathological specimens from a boy who died at fourteen years of age after suffering for eight years with coxa plana. The writer also presents numerous serial roentgenograms, some of them taken several years before the onset of the bone changes. He finds that the flexion-abduction position of Lauenstein shows the early changes much more readily than the anteroposterior view.

Contrary to the views of Murk Jansen and Calot, the writer finds that coxa plana develops in hip joints which previously have been normal. This is shown in a case of bilateral coxa plana where the second hip, which is normal in the first two roentgenograms, shows the typical changes after three years. The symptoms are present several months before the roentgenograms show changes. The earliest diagnostic sign is flattening of the epiphysis. This has been observed by the writer one month after the appearance of symptoms. The distance from the medial part of the epiphysis to the bottom of the socket,—*i.e.*, the lateral leg of the U-shaped figure, is also greater than normal. This distance increases with the progression of the disease. At first the shape of the acetabulum is normal. Later it changes to adapt itself to the deformed head. When the adaptation is complete, the distance of the epiphysis to the bottom of the acetabulum becomes normal again.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Ueber Verletzungen der Ligamenta Cruciata des Kniegelenkes und Deren Behandlung (Injuries of the Crucial Ligaments and Their Treatment). Nils Silfverskiöld. *Acta Orthop. Scandinavica*, V, 35, 1934.

A knee injury diagnosed as injury of the crucial ligaments was treated by aspiration and fixation for eight weeks, with complete recovery. Another patient with avulsion of the tibial spine and rupture of both semilunar cartilages was operated upon with a good

functional result. In a third case, a posterior crucial ligament was repaired by transplant of the semitendinous and half of the semimembranous tendons which were also used to reinforce the collateral ligaments. Nine months later there was good stability with ninety degrees of motion. The writer emphasizes the value of conservative treatment in the early case.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Versuche Einer Deutung der Pathogenese der Skelettveränderungen bei Chondrodystrophia Foetalis (The Significance of the Pathogenesis of the Skeletal Changes in Chondrodystrophia Foetalis). Ake Wilton. *Acta Path. et Microbiol. Scandinavica,* Supplementum XV, 1, 1933.

A beautifully prepared monograph of more than 160 pages presents the subject of chondrodystrophia from all angles. Four foetal preparations showing this deformity are presented. After an exhaustive study of the histopathological changes, the writer concludes that chondrodystrophia foetalis is *in fact* foetal rickets and should be called by its original name. The argument is rather involved for an orthopaedic surgeon, but should delight the heart of a pathologist.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Union of Pathological Fractures Following Metastatic Hypernephroma. Edwin L. Rypins. *Am. J. Cancer,* XX, 601, March 1934.

The author reports a case of a patient forty-six years old with a large hypernephroma of the right kidney, treated by nephrectomy. About a year later, an extensive osteolytic tumor appeared in the mid-part of the left ulna which was treated with 1000 roentgen units. The patient later sustained a pathological fracture of the tibia through another metastatic focus. No x-ray therapy was used over the tibia. Six months later roentgenographic examination showed definite healing of both the tibia and the ulna, with bony union of the pathological fractures.

In discussing the case, the author states that a careful search of the literature failed to disclose any other case of metastatic hypernephroma of the skeleton which showed union following pathological fracture. Radiation therapy may have influenced healing of the fracture of the ulna, but the tibial fracture healed without such treatment.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

Moderne Behandlung Unkomplizierter Kompressionsbrüche der Brust- und Lendenwirbelsäule. Mitteilung über die Behandlungsergebnisse der Wirbelsäulenbrüche nach Watson-Böhler (Modern Treatment of Uncomplicated Compression Fractures of the Dorsal and Lumbar Spine. Report of Results of Treatment of Spinal Fractures According to Method of Watson-Böhler). Fritz Felsenreich. *Arch. f. Klin. Chir.,* CLXXVI, 123, 1933.

As a result of clinical and pathological anatomical observations, the following basic principles have been developed:

1. In the majority of compression fractures of the vertebrae, the ligamentum longitudinale anterius and the ligamentum longitudinale posterius are intact and the intervertebral discs are in firm union with these ligaments.

2. The posterior portions of the vertebral bodies are mostly intact, and the spinal cord in these cases is protected by the integrity of the ligamentum longitudinale posterius.

3. The articular processes are fractured only in exceptionally severe cases and the vertebral body is subluxated or dislocated.

4. The ligamenta interspinalia are torn and the spinous processes are fractured or further separated from each other.

5. The spinal column shows a pathological flexion angulation, with a forward shifting of the center of gravity.

From these principles it is concluded that it is possible, by reclination, with or

without traction, to reduce the subluxated joints and to restore the axis of the spinal column.

Following the method of Böhler, the author treated, within nine months, twenty-four patients with fracture of the dorsal or lumbar spine. Fractures above the ninth dorsal vertebra could not be influenced by this treatment.

During the course of fracture of the spine, four stages are distinguished:

1. The stage of immediate traumatic shock.
2. The stage of retroperitoneal hematoma, manifested by abdominal and circulatory disturbances.
3. The stage of consolidation of the fracture.
4. The stage of adjustment of the rest of the column and the entire motor apparatus to the altered vertebra.

The first stage may last from several hours to two days and it is characterized by changes which are produced by fat embolism. Practically, it is very important to recognize this stage as its close is the most favorable time to effect reduction.

The second stage is characterized by symptoms resulting from the fracture hematoma. The main feature is an ileus, often accompanied by embarrassment of the circulation and respiration. This stage may last from eight to fourteen days. If reduction of the fracture cannot be completed before the onset of this stage, it is preferable to delay the reduction until this stage has passed.

The third stage is that of consolidation of the fracture, and it is generally estimated to be the period from the third to the sixteenth week after injury. It is during this stage that activation of the muscles should be instituted to prevent atrophy.

The fourth stage begins with the transition from the reclining to the upright position of the patient, and corresponds to the period during which adaptation to an altered position of the spine takes place. It is during this stage that functional treatment of the spine and of the whole body is emphasized.

Reposition of the fracture is carried out under spinal anaesthesia. The patient is suspended between two tables to obtain the maximum degree of lordosis of the spine. Retention is by means of a plaster cast, unpadded, except at the point of maximum lordosis posteriorly.

The technique of reduction and application of the cast are described in minute detail.

Functional treatment in the form of gymnastics may be instituted eight to ten days after reduction. The length of time required for union varies from six weeks to five months.

Case reports are given of twenty-four patients, treated by this method.

Further comments by the author emphasize the possibility of reduction of fractures of the spine, the possibility of retention, the advantages over the purely functional method of treatment, and the possibility of shortening the fourth stage of the injury.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

WEITERE ERFAHRUNGEN BEI DER BEHANDLUNG VON WIRBELBRÜCHEN (Further Experiences in the Treatment of Fractures of the Spine). Lorenz Böhler. *Arch. f. Klin. Chir.*, CLXXVII, 424, 1933.

The author emphasizes the possibility of reducing compression fractures of the spine within two weeks after injury.

If a gibbus develops as a result of spinal fracture, and can no longer be corrected, the treatment should be directed toward a realignment of the rest of the spine. The cause of symptoms following a fracture of the spine is the malalignment of the column, and the severity of the symptoms is directly proportional to such malalignment. Faulty alignment of this type can be corrected within eight weeks after the injury.

The reduction is done under local anaesthesia, according to the method of Schnek. Hyperextension of the spine is produced with the patient in the prone position. An

unpadded plaster cast is applied to maintain correction. In case of paralysis with spinal fracture, this treatment is also effective and is preferable to a laminectomy.

In fractures which show an angulation of the spinal column up to twenty degrees, three months are required for solid union. Where the angulation is greater than twenty degrees, four months or more are required.

One or two days following reduction and application of the cast, the patient is required to perform systematically a number of exercises designed to activate the muscles and also as a psychic stimulus.

This report is based on observation and treatment of eighteen cases. A comparison is made between the results of this method of therapy and those of other methods. The resulting disability is much less than that obtained by other writers, using different forms of treatment.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Spätschädigungen im Gebiete des Nervus Ulnaris nach Ellbogenverletzungen bzw. Arthritis Deformans mit Besonderer Berücksichtigung der Unfall-Begutachtung (Late Lesions of the Ulnar Nerve, Following Injuries to the Elbow, or as a Result of Arthritis Deformans, with Particular Reference to Compensation Reports). Collin. *Arch. f. Orthop. u. Unfall-Chir.*, XXXIII, 551, 1933.

This article is of importance, since, after an extensive experience with paralysis of the ulnar nerve, Dr. Collin has been able to show that in a large percentage of cases the nerve symptoms are not due to injury to the elbow, but to an arthritis which has developed independently of trauma. He lists four conditions which must be met before the paralysis can be attributed to the injury:

1. There must be definite evidence of an injury to the elbow.
2. The injury must be of sufficient severity to cause the injured person to be declared sick, and to have medical attention.
3. The joint injury must not have occurred ten or more years before.
4. Only the injured joint may show evidences of arthritis.

In every case it is advisable to take x-rays of the numerous other joints, in order to determine whether the arthritic changes are due to local or general causes.

Dr. Collin calls attention, however, to one type of arthritis which can properly be attributed to industrial injury,—namely, that occurring in workers who use compressed-air instruments. He reports two cases where, under these conditions, there was definite evidence of localized arthritis of the right elbow, with a complicating ulnar nerve involvement.—*Leo Mayer, M.D., New York, N. Y.*

Winkelbildung am Proximalen Femurende Zwecks Korrektur der Fehlerhaften Funktion des Verrenkten Hüftgelenkes (Change of Angle at the Proximal End of the Femur for the Correction of Malfunction of the Dislocated Hip). Eugen Kopits. *Arch. f. Orthop. u. Unfall-Chir.*, XXXIII, 586, 1933.

This paper is based on a study of forty-seven patients with dislocation of the hip, thirty-nine cases being of the congenital type. Seven of the patients with congenital dislocations had bilateral dislocations. Kopits made a careful study of the end results following the bifurcation operation of Baeyer and Lorenz. He found that the good results were not due to the impinging of the distal fragment against the acetabulum, since, as shown by control roentgenograms, this fragment of the femur was found invariably to have atrophied and finally to have entirely disappeared. He, therefore, modified the bifurcation operation in such a way as to eliminate the shortening due to the original setting of the distal fragment.

The line of the osteotomy is made in much the same direction as in the original operation. The distal fragment, however, is made to impinge against the cut surface of the proximal fragment at its upper tip, instead of being shoved forward and inward, so that the lateral surface of the femur comes in contact with the cut lower end of the

proximal fragment. The proximal fragment is held adducted as far as possible, and the plaster is applied in two steps, by the method of Dollinger, so as to maintain the fragment in the adducted position, while the distal fragment is held abducted at an angle of forty degrees.

Kopits reports a number of gratifying results. Although a slight limp is still present, the Trendelenberg sign disappears and there is a marked improvement in the patient's gait.—*Leo Mayer, M.D., New York, N. Y.*

RELATIONSHIP BETWEEN ANATOMIC CHANGES IN KNEE JOINT WITH ADVANCING AGE AND DEGENERATIVE ARTHRITIS. Chester S. Keefer, Frederic Parker, Walter K. Myers, and Ralph L. Irwin. *Arch. Int. Med.*, LIII, 325, March 1934.

A systematic study was made of 100 knee joints removed at seventy-seven consecutive necropsies, in order to obtain information in regard to changes which may be encountered with advancing age.

The only cases excluded from the group studied were those in which there was a definite infection of the joints, as determined by bacteriological examination of the joint fluids.

There were no symptoms referable to the joints recorded in the clinical histories of sixty-six patients, and pain and stiffness were present in only eleven of the seventy-seven patients. The patella showed alterations in eighty-one per cent. of the cases, the interpatellar groove in eighty-five per cent., the lateral condyle of the tibia in sixty-four per cent., the medial condyle of the tibia in fifty-five per cent., the medial condyle of the femur in forty-three per cent., and the lateral condyle in thirty-six per cent.

An analysis of the mechanics of the knee joint showed that alterations were most common over the areas of contact which were subjected to the greatest movement, strain, weight-bearing, and injury. The alterations varied greatly in character and degree. In some instances there was simple fibrillation of the cartilage with irregularity of the surface; in other cases there was loss of varying amounts of cartilaginous substance, so that occasionally the underlying bone was exposed. When the bone was exposed it gave the appearance of so called eburnated bone. These changes increased in frequency with advancing age. In the fifth and following decades they were present in ninety to 100 per cent. of the cases. It is difficult to escape the conclusion that these changes are precisely the same as those described as being characteristic of so called degenerative arthritis.

The alterations in so called Charcot's joints must be regarded as the result of frequent traumata to joints which have been rendered insensitive to pain by a nerve lesion. Changes in the joints in patients with hemophilia, brought about by repeated trauma and hemorrhage, are often indistinguishable from those of degenerative arthritis.

There is justification for the belief that degenerative arthritis is a process associated with aging of the tissues of the joints. Added to the process of involution, such factors as gross trauma, hemorrhage, and static deformities exaggerate the condition. The end result depends on the summation of these factors.—*Clark W. Heath, M.D., Boston, Massachusetts.*

DIE SUBLUXATION DES HÜFTGELENKS INFOLGE ENTWICKLUNGSHEMMUNG DER PFANNE (Subluxation of the Hip Joint as a Result of Developmental Arrest of the Acetabulum). B. Simons. *Beitr. z. Klin. Chir.*, CLVII, 505, 1933.

Six cases are reported as they appear in childhood and adolescence, and three cases as seen in middle age. This condition may be bilateral or unilateral, may be associated with congenital dislocation of the hip, and may show, in addition, either a coxa vara or a coxa valga. The most common clinical feature is a limp and this is commonly associated with pain in the hip, at times quite early in life.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

RICHTLINIEN UND PHYSIOLOGISCHE GRUNDLAGE DER FUNCTIONELLEN BEHANDLUNG UNKOMPLIZIERTER WIRBELBRÜCHE (Physiological Basis of Functional Treatment of Uncomplicated Fractures of the Spine). Hans Kraus. *Deutsche Ztschr. f. Chir.*, CCXLI, 553, 1933.

The basic principle of present-day fracture treatment—reposition, fixation, and functional treatment immediately following successful immobilization—is applicable also to fractures of the spine. Functional treatment of spinal fracture, according to the author's conception, consists exclusively of active exercises, which are to be instituted after reduction and fixation of the fractured part in a plaster cast. Such exercises are indispensable for a satisfactory result, and they are to be continued as long as possible, at least for one year. Such active exercises serve to strengthen the entire musculature, to eliminate arrested movement produced by the cast, and to restore the normal condition of the musculature, which has been placed in an unphysiological attitude and primarily traumatized. Psychotherapy and the prevention of a compensation neurosis are the main features of the plan of treatment. After fixation in the plaster cast, the patients are no longer in need of hospitalization. After removal of the cast, a short period of guarded activity may be followed by light work; and, depending upon the severity of the condition, the patient may in a few months undertake heavy work.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

DOUBLE PULLEY TRACTION IN FRACTURES OF THE SHAFT OF THE HUMERUS. REPORT OF A CASE. Lester Blum. *J. Am. Med. Assn.*, CI, 1953, 1933.

The method previously used at the Beekman Street Hospital has been adhesive traction to the arm with the forearm suspended at right angles. In muscular patients, or in cases of compound fracture, the adhesive was replaced by pin traction through the olecranon. Slipping of the adhesive plaster and irritation of the skin constituted real problems. The functional results obtained were good, but the anatomical results were only fair to poor.

The principles of Russell's method of traction for fractures of the femur are now applied in the treatment of fractures of the humerus and the apparatus is made so as to attain accurate axis traction on the upper extremity. The traction is obtained through adhesive plaster applied to the forearm.

The apparatus consists of a well padded cuff which partially encircles the elbow, with its pressure broadly distributed over the skin of the cubital fossa, a continuous length of rope, a series of three pulleys, and a hand spreader. Two forces are projected,—the greatest is upward, is transmitted through the hand spreader, and is equal to twice the suspended weight; the second force is downward, is transmitted through the cuff in the cubital space, and is equal to the suspended weight.

Advantages of the method are: (1) accuracy of the traction; (2) ability to elevate the patient's head without disturbing the position of the fracture; (3) freedom of the arm, especially important in a compound fracture; (4) anaesthesia or operation unnecessary.

One case is reported which has been successfully treated by this method.—*W. B. Carrell, M.D., Dallas, Texas.*

STIFF, PAINFUL SHOULDERS, EXCLUSIVE OF TUBERCULOSIS AND OTHER INFECTIONS. Edson B. Fowler. *J. Am. Med. Assn.*, CI, 2107, 1933.

The article is devoted to: (1) a review of synonyms; (2) an analysis of pathology; (3) a study of the rôle of rupture of the supraspinatus tendon, capsule, and bursa as an etiological factor; (4) a review of a few cases; (5) a brief outline of treatment; (6) an outline of a simple operation for tendon and capsule repair.

The purpose of the article is to direct attention to evidence that rupture of the supraspinatus tendon is apparently the primary exciting cause of most stiff, painful shoulders. Codman found complete rupture of one in every twenty shoulders examined

at autopsy and one partial rupture in every third shoulder. In a study of 340 shoulders, the author found one complete rupture in every twenty-eight shoulders examined and one incomplete rupture in every six shoulders. Deposits were found in more than one-third of the cases of rupture. These deposits were in and about the supraspinatus tendon. In the absence of tear, no degenerative changes were found.

Codman believes that all ruptures of the supraspinatus tendon are caused by contraction of the supraspinatus muscle and that tear is rarely due to direct trauma. The rupture may be complete after one insult, or may be gradual in cases of chronic strain upon the tendon. Care in taking the history of these cases in great detail is of the utmost importance as it will often be disclosed that there has been sudden stress placed upon the tendon, or that there has been long continued overuse.

In the light of this evidence, exploration of the shoulder under local anaesthesia is easily justifiable, especially where no etiology can be established and no improvement has occurred under conservative measures. The operation is done under local anaesthesia in the first stage and the supraspinatus tendon is inspected.

In the case of a rupture, repair is done under general anaesthesia. The first skin incision is extended and the acromion is cut through from without inward, beginning half an inch behind the acromioclavicular joint. Retracting this fragment forward exposes the ruptured tendon. The greater tuberosity is drilled and then, with the arm in abduction, the ruptured tendon is made secure to the greater tuberosity with linen or silk sutures. After two weeks, the arm is lowered to a sling and gradual use is encouraged as the soreness from the operation subsides.—*W. B. Carrell, M.D., Dallas, Texas.*

Familial Neurotrophic Osseous Atrophy. A Familial Neurotrophic Condition of the Feet with Anesthesia and Loss of Bone. E. Maurice Smith. *J. Am. Med. Assn.*, CII, 593, Feb. 24, 1934.

This unusual clinical condition has been observed in two generations of a family and there is a definite history of its existence in a third generation. The condition is characterized by ulcers on the plantar surface of the feet and toes, with anaesthesia and loss of bone.

Six cases are reported,—one son by the father's first marriage, two sons by his second marriage, and three sons of the first patient mentioned.

Syphilis, tuberculosis, and syringomyelia were ruled out. A consultant with a wide experience in treating leprosy thought the condition not of that etiology.—*Ike Kendrick, M.D., Dallas, Texas.*

Delayed Appearance of Deformity in Vertebral Body Fractures. O. O. Feaster. *J. Am. Med. Assn.*, CII, 599, Feb. 24, 1934.

Low back pain may be a sequela of an undiagnosed compression fracture. The trauma necessary to produce a compression fracture may be surprisingly insignificant. Roentgenograms taken after an injury may not show a compression fracture, but those taken a few hours to several days after the injury may show well defined deformity of the vertebral body. At the time of the injury the disturbance of the nutrition and homogeneity of the bone is not sufficient to deform the body at the time, but predisposes the body to deformity and so weakens its structure that the patient's weight or movements causes the weakened body to collapse and so accounts for the typical roentgenographic picture at a later examination. The persistence of symptoms after an injury is absolute indication for the taking of further roentgenograms of the spine, including a lateral view.

The so called cases of Kümmell's disease probably fall into this group of cases, and it is seriously doubted that Kümmell's disease should be considered as a disease entity.

It is pointed out that the fracture may exist from five to seven vertebrae above the site of pain.—*W. B. Carrell, M.D., Dallas, Texas.*

SECOND ATTACKS OF POLIOMYELITIS. REVIEW OF THE LITERATURE AND REPORT OF A CASE. T. B. Quigley. *J. Am. Med. Assn.*, CII, 753, March 10, 1934.

It is probable that no infectious or contagious disease confers permanent immunity. Second attacks of almost all such diseases have been reported.

Fourteen cases in which second attacks of acute poliomyelitis have occurred are recorded in the literature. These second attacks must be distinguished from relapses. Still has observed that the relapses almost invariably occur within three months.

The interval between the longest reported relapse and the earliest true recurrence is two years. The interpretation of the significance of this period cannot now be decided, but, as has been suggested, it probably represents the minimum duration of immunity.

Eleven of the fourteen cases reported in the literature appear to be reasonably definite. Still's tabulation of these eleven cases lists an interval of from two to twenty years between the attacks.—*W. B. Carrell, M.D., Dallas, Texas.*

THE INCIDENCE AND PATHOGENESIS OF DEGENERATIVE ARTHRITIS. Chester S. Keefer and Walter K. Myers. *J. Am. Med. Assn.*, CII, 811, March 17, 1934.

In determining the incidence of chronic degenerative arthritis, three general methods are used: (1) post-mortem examination of the joints; (2) roentgenographic examinations; (3) determination of the number of patients having symptoms referable to the joints. Of these three methods, the first is by far the most satisfactory. In order to gather more precise information, 150 knee joints were examined.

Lesions were found to increase with age, and the areas showing the most striking changes were those subjected to the most weight, movement, pressure, and trauma. In the knees examined, the areas involved were in order of frequency: (1) the patella; (2) the intercondylar areas of the femur; (3) the condyles of the tibia; and (4) the condyles of the femur. The frequency of changes also increases with age. Between the ages of twenty and forty years, sixty per cent. of the patients showed defects; between forty and fifty years, ninety-five per cent.; and 100 per cent. of older patients.

What has been said of the knee joint also applies to other joints, especially to the joints of the spine. All observers have agreed that the condition increases with age.

In addition to age, the condition is influenced by occupation, static deformities, and trauma.

Trauma to joints, such as in joint fractures, and hemorrhages into joints, as in hemophilia, and repeated injuries to joints, as in tabes dorsalis and syringomyelia, are the causes of alterations in joints giving the picture of degenerative arthritis.

From a gross and histological view-point, the evolution of the process is as follows: As a result of the aging of the cartilage or of gross trauma, the cartilage loses its elasticity and becomes split or fibrillated in the vertical plane. Following this change, the damaged cartilage no longer protects the subchondral plate of bone from pressure, weight and impacts, as does normal cartilage. Following the loss of the cartilage, the underlying bone becomes very dense and the surface highly polished. The marginal spicules seen in these joints are not due to bony overgrowth, but to depression of the normal joint line, so that the edge projects over the margin of the bone like a mushroom.

The authors conclude that degenerative arthritis increases with age, and that anatomical changes are due to wear and tear and not to any particular disease process.—*Ike Kendrick, M.D., Dallas, Texas.*

CREPITANT ANTESCAPULAR BURSITIS. V. A. Astrakhanski. *New Surg. Arch.* (U.S.S.R.), XXIX, 3, 1933.

The crepitation observed in these cases is due to a proliferative bursitis, developed over an exostosis on the anterior surface of the scapula. The affliction is a definite clinical entity and should be differentiated from other diseases of the costoscapular region A pathognomonic sign is described by the author. On deep inspiration and expiration

the intensity of the crepitation diminishes; on moderate inspiration, the crepitation is more intense. This is not observed in any other condition around the shoulder. The treatment is surgical and consists of the removal of the inflamed or calcified bursa and a plastic covering of the denuded area.—*Emanuel Kaplan, M.D., New York, N. Y.*

THE OPERATIVE TREATMENT OF CALCANEAL SPURS. N. Markelov and A. Illin. *Orthopaedia i Travmatologia*, VII, No. 1, p. 49, 1933.

The authors observed thirty patients, twenty of whom gave a history of Neisserian infection. As a rule, the pain in the heel appeared from three to eight months after the onset of the acute infection. The pain is caused by periostitis of the spur, with bursitis. Ten of the thirty patients had associated pes planus. Seventeen patients underwent operation. The operative technique is simple. Under local anaesthesia, a horizontal horseshoe incision is made encircling the heel; the flap is thrown down and the spur is removed by chisel. The wound is closed without drainage. No simultaneous operative procedures for the improvement of any other condition of the foot are advised. The postoperative results are very satisfactory.—*Emanuel Kaplan, M.D., New York, N. Y.*

THE CLINICAL COURSE AND PATHOLOGICAL ANATOMY OF THE HYDATID ECHINOCOCCOSIS OF BONES. M. Khovenko and K. Elenvsky. *Orthopaedia i Travematologia*, VII, No. 2, p. 3; No. 3, p. 1, 1933.

In a detailed study, the authors review the literature of this affliction and describe four cases observed and treated by them. The patients did not have much contact with dogs; their disease had a protracted course. The correct diagnosis was suspected in a single case only. No eosinophilia was observed. Two patients were operated on. In one case, in which the knee was involved and subsequently proved to be echinococcic, the roentgenographic and the gross operative aspects were typically tuberculous.

The authors conclude that the positive clinical and roentgenographic diagnosis is difficult. They find that the bone reacts differently to the hydatid and multilocular echinococcus. The hydatid type gives a more benign course. The multilocular type always produces emaciation and simulates tuberculosis. Weinberg's test seems to be diagnostically reliable. An early recognition of the disease, with a timely and extensive operation, ought to give favorable results.—*Emanuel Kaplan, M.D., New York, N. Y.*

A COMPARATIVE ANALYSIS BETWEEN THE PATHOGENESIS OF OSTEODYSTROPHIES AND BONE TUMORS. Isaac Levin. *Radiology*, XXII, 266, March 1934.

Tumors of the bone may be indistinguishable morphologically and roentgenographically from inflammatory, metabolic, or endocrine diseases of the bone. Primary sarcoma, metastatic carcinoma, osteomyelitis, syphilis of the bone, and the various types of osteodystrophies may present pictures so similar that a differential diagnosis becomes impossible. Von Recklinghausen came to the conclusion that osteitis fibrosa presents close analogies with Paget's disease of the skeleton and osteomalacia on the one hand, and with metastatic carcinoma of the skeleton on the other.

There are two classes of skeletal metastases of carcinoma: osteoplastic, in which extensive new bone formation takes place around the metastatic tumor; and osteoporotic, in which the changes in the normal tissues surrounding the metastasis consist of destruction of the compact bone. The microscopic study of the cases analyzed by the writer showed that both conditions were generally present side by side. The differences in the gross appearance are due to the fact that in one case osteoplasia, or new bone formation, predominates, while in another osteoporosis, or the destruction of the old bone, is mainly in evidence.

Osteitis fibrosa and osteitis deformans appear to be morphologically and roentgenographically similar to osteoplastic metastatic carcinoma of the skeleton. There

must also be, therefore, some similarity in the mechanism of the formation of the two conditions.

It is significant that the types of carcinoma which most frequently develop metastases in the bones are carcinoma of the breast, of the prostate, and of the thyroid,—*i.e.*, organs with active endocellular metabolism and endocrine functions.

The destruction of normal bone tissue (osteoporosis) in skeletal metastasis is a purely local process and, as already stated, must be a direct function of the group of cancer cells transported to the bone. This function is most probably chemical, in accordance with Von Recklinghausen's conception, and the resultant change in the bone, as he thought, is analogous to the condition found in osteomalacia.

The new bone formation (osteoplasia) is undoubtedly an attempt at self defense—a reactive or reparative process—and the mechanism of its formation is identical in all types of bone tumors or osteodystrophies.—*Edward N. Reed, M.D., Santa Monica, California.*

HIP JOINT CHANGES IN HEMOPHILIA. Max Kahn. *Radiology*, XXII, 286, March 1934.

Schloessman estimates that one-third of all hemophiliacs are free from joint symptoms, whether sporadic cases are examined or whether the members of a single family of males are investigated.

The usual onset of symptoms is in the first or second year, following the small injuries to which the joints are normally subjected. Many cases, however, appear to have their onset just before adolescence, between the ages of nine and thirteen years. Apparently hemorrhages in the region of the joints, which are responsible for the hemophilic arthropathy, may, in some cases, occur spontaneously. The knee joint is by far the most frequently involved, followed in the order of their frequency by the elbow, ankle, and hip joints. The hands and shoulder joints are rarely involved. In isolated instances, the fingers or the temporomandibular joints may be affected.

In the first or second year of the joint disturbance, the roentgenogram is usually negative. Later, when limitation of motion occurs in the joint, the roentgenogram will show atrophy of the neighboring bones. This is followed by destruction of the joint surfaces, with periarticular irregularities, resembling arthritis deformans. The joint cartilage disappears and the joint surfaces approach each other. Synostosis may occur. Accompanying these intra-articular changes, there are usually periarticular manifestations. The earliest of these may be a hazy shadow in the soft parts, caused by periarticular hemorrhage, which later may be followed by calcification and ossification. The bones about the joints become enlarged and broadened across their articular surfaces.

In the early stages, the roentgenographic changes may resemble those of tuberculosis, osteochondritis, or coxae juvenilis; later they simulate osteitis deformans. The family history and the patient's past history of bleeding are the most important factors in the differential diagnosis. Another point of differentiation is the short duration of pain, which in the hemophilic joint subsides after four to six days.

Key is of the opinion that bony ankylosis does not occur in hemophilic arthritis. He states that the changes in the cartilage, which are characteristic of a hemophilic joint, have a map-like appearance, due to cartilage destruction, and that the characteristic change in the bone is the formation of cavities in the intra-articular portion. He believes that bone destruction does not occur until late in the disease, and that at some stage of the disease the bone becomes markedly atrophic as a result of disuse. The areas of bone destruction are frequently so extensive that they are clearly visible in the roentgenogram.

Marked hemarthrosis, due to bleeding from the synovial membrane or periarticular structures within or about the joints, is most common in the region of the knee or elbow. Roentgenographically, however, changes about the hip joints of hemophiliacs are rare.

Recently a case of hemophilia was treated by intramuscular injection with ovarian extract, with an excellent result. Birch is credited with the discovery that a hormonal disturbance exists in hemophilia which is temporarily relieved by parenteral administration of ovarian substances.—*Edward N. Reed, M.D., Santa Monica, California.*

De L'Arthrodèse de la Hanche Dans le Traitement de la Coxalgie et Son Dangereux Équivoque (Arthrodesis of the Hip in the Treatment of Coxalgia and Its Uncertain Results). Jacques Calvé. *Rev. Med. Française*, XV, 225, 1934.

Dr. Calvé discusses the subject of arthrodesis of the hip in the treatment of tuberculous coxitis largely from the standpoint of the conservative French orthopaedic surgeon. He emphasizes the fact that attention must be given to four principles in the treatment advocated by most of the conservative orthopaedic surgeons in the larger centers, such as Berck, Leysin, etc.: (1) hip disease is but a local manifestation of general disease; (2) strict immobilization of the focus is necessary during the acute period of the disease; (3) the cold abscess must be considered frequently as a concomitant of the disease and should not have surgical treatment by opening; (4) a closed tuberculous focus should never be opened surgically.

He discusses the principles in general and gives statistics which have been obtained from the two methods of treatment,—the conservative method in his own Clinic at Berck; and the operative method in the Clinic of Vignard at Lyon. A comparison of the two methods shows far more favorable results obtained by the conservative treatment, both in regard to the number of cures and, particularly, the number of persistent fistulae.

He then compares the statistics given by different authors in the literature and emphasizes the need of distinguishing between extra-articular arthrodesis and intra-articular arthrodesis. He feels that intra-articular arthrodesis should never be used, since it opens into the focus of disease, but that extra-articular arthrodesis has its place in the treatment of these cases.

Fractures and Dislocations of the Tarsal Bones. Philip D. Wilson. *Southern Med. J.*, XXVI, 833, 1933.

This paper is based upon a study of 4,536 cases of fractures and dislocations treated at the Massachusetts General Hospital between 1923 and 1930. In practically two per cent. of the cases the tarsal bones were involved.

Severe cases of fracture of the os calcis with involvement of the subastragalar joint are best treated by subastragalar arthrodesis at the end of three weeks, unless a very accurate reduction has been obtained by manipulative methods.

The author stresses the importance of careful diagnosis, accurate reduction, and proper after-care for successful results in these important weight-bearing structures.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

Non-Operative Versus Operative Treatment of Tuberculosis of the Spine in Children. J. H. Kite. *Southern Med. J.*, XXVI, 918, 1933.

The author gives the results of fifty cases treated by each method at the Scottish Rite Hospital in Decatur, Georgia. The patients were all treated alike in regard to rest in bed, good food, fresh air, and sunshine.

The operations in the past three years have been done under local anæsthesia. If it is necessary to fuse more than six vertebrae, the operation is done in two stages. The Hibbs method is used.

In the non-operated group of fifty cases, an excellent result was obtained in only one case. Satisfactory results were obtained in seven cases. Fourteen cases showed improvement; eleven cases no improvement.

In the operated group of fifty cases, excellent results were obtained in thirty-four. These thirty-four cases were the only ones in which adequate operations had been performed. Thirty per cent. of the patients had inadequate fusions and required further operations.

There was only one operative death which occurred in the early days of spine fusion. In the group in which the patients had had inadequate operations, there was one death two and one-half years after operation and one six and one-half years after operation.

There were no deaths among the thirty-four patients who had had adequate operations.

This is an excellent article and is well illustrated.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

TREATMENT OF FRACTURES IN THE LOWER THIRD OF THE LEG. W. B. Carrell. *Southern Med. J.*, XXVI, 1054, 1933.

This is a consideration of 100 cases in which satisfactory results were not obtained by the usual methods of treatment. There were twenty-three cases of compound fracture, twenty of incomplete reduction, seventeen of malunion, twenty-three of non-union, and seventeen of delayed union. From a study of these cases the author draws the following conclusions:

1. Early reduction and gentle manipulation will reduce circulatory complications.
2. Circulatory damage (arterial ischaemia) is an important factor in delayed union.
3. Accurate reduction promotes better circulation and shortens convalescence.
4. Fixation must be adequate to control movements at fracture site, and must be maintained until union is firm.
5. Proper protection for function must be arranged during convalescence.

The author advocates the application of walking plaster next to the skin, after the method of Böhler, to hasten union and to bring about the return of function.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

OBLITERATIVE ENDARTERITIS IN WOMEN. N. Kukin. *Soviet Surg.*, VI, 40, 1934.

The author describes two cases observed in women. From a review of the literature and from personal experience, he concludes that this affliction has a milder course in women and is, therefore, frequently overlooked.—*Emanuel Kaplan, M.D., New York, N. Y.*

ÜBER ANPASSUNGSVORGÄNGE DES KNORPEL- UND KNOCHENGEWEBES IM VERSTEIFTEN GELENK (Compensatory Changes of Cartilaginous and Osseous Tissue in Ankylosed Joints). S. Milton Rabson. *Virchow's Arch. f. Path. Anat.*, CCXCI, 624, 1933.

The internal construction of the bony framework has a remarkable inherent ability to undergo changes to accommodate pathological conditions which change its lines of stress and strain. According to Roux, a continuous stress is responsible for the maintenance of normal bony construction.

By means of experiments, the author demonstrates various structural changes in bones in response to altered stress in pathological conditions. Since inflammatory conditions themselves produce atrophic changes during the process of ankylosis, the actual cartilaginous and osseous atrophy of disuse were determined by the author after amputation of the lower leg, due to gangrene of the foot; the cartilage and synovia were thus left intact over the articular surfaces of the patella and femur. Due to an intercurrent disease, the patient died some two and a half years later. At autopsy these articular surfaces revealed an entire absence of cartilage except for two small peripheral islands with the remaining portions covered by pannus and fatty infiltration. Closer examination showed an irregular, calcified zone covering the diaphysis, with uneven haversian canals, etc. The pannus, composed of progressive but incomplete calcification among connective-tissue proliferations, extended to the diaphyseal ossification and united with it. Some areas presented an osseous surface, rather porous but continuous with the underlying diaphysis.

The author concludes from his experiments that in all ankylosed joints the intervening cartilage disappears in time. However, when the joint begins to function again, the epiphyseal cartilage is regenerated about the remaining cartilaginous "rests", or new cartilage may form over the functioning articular surface.—*Paul H. Rempel, M.D., Oklahoma City, Oklahoma.*